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IMPROPER CHURN: SOCIAL COSTS AND
MACROECONOMIC CONSEQUENCES

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Improper Churn:
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Abstract

    This paper assembles elements that are essential in forming an integral picture of the way a "churning" economy functions, and of the disruptions caused by transactional difficulties in labor and financial markets. We couch our analysis in a stochastic equilibrium model anchored with US evidence on gross factor flows and on rents in worker and firm income. We develop a social accounting framework to measure the costs of transactional impediments. We calculate the average social loss associated with structural unemployment and low productivity — due to technological "sclerosis" and a "scrambling" of productivity rankings in entry and exit decisions. We also estimate the loss from a recession. An additional forty percent to the traditional unemployment cost is due to reduced productivity, and is determined by the recession's *cumulative* effect on the economy's churn rate. Although a recessionary shock increases the economy's "turbulence" at impact, semi-structural VAR evidence from US manufacturing indicates that, cumulatively, it results in a "chill" — which is costly in an economy that suffers from sclerosis.

1 Motivation and Summary

A main theme of recent research in macroeconomics is the nature and implications of the "churn" — the massive process of on-going factor reallocation

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through which the economy's productive structure adjusts to innovations and shifting economic circumstances.[1] Beyond being an object of study by itself, this underlying churn view of the economy seems indispensable in addressing questions as central as: What determines the rate of unemployment? What is the macroeconomic impact of transactional impediments in factor markets? How do these impediments affect the efficient use of production opportunities? What is the cost of recessions? This paper is an attempt at assembling elements that seem essential in forming an integral view of the way a churning economy functions, and allow us to address such questions meaningfully. We couch our framework in a stochastic equilibrium model that we quantify and use to explore data.

To be concrete, consider the traditional question of the "cost of recessions." What are the costs of possible maladjustment to an adverse aggregate shock? Suppose we compute "social welfare" as the present value of aggregate consumption discounted at rate ρ. The welfare effect of maladjustment can then be generally written as

$$\left(V^h - c\right) \int_0^\infty \left[H(t) - \overline{H}(t)\right] e^{-\rho t} dt - V^d \int_0^\infty \left[D(t) - \overline{D}(t)\right] e^{-\rho t} dt + \mathcal{S}. \quad (1)$$

$H(t)$ and $D(t)$ denote the path of gross creation and destruction in response to the shock; while $\overline{H}(t)$ and $\overline{D}(t)$ denote the path of those variables absent the shock. V^h and V^d denote appropriately defined social values of jobs on the creation and destruction margins; and c is the cost of creating a job. $\mathcal{S}$ denotes a residual term that reflects a compositional effect of the shock on the productivities of units created and destroyed.[2] Expression (1) gives the welfare effect as the sum of the social value of creating a unit times the cumulative response of creation, the social loss from destroying a unit times the cumulative response of destruction, and the compositional term. Naturally, in an efficient equilibrium, the social values of creating or destroying a marginal unit are zero ($V^h - c = V^d = 0$), and the welfare cost of maladjustment is therefore zero. It is because of eventual distortions that make those social values non-zero, combined with the precise response of gross flows, that such a social cost arises.

An aspect of the maladjustment cost of recessions can be gleaned from

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[1]For recent studies that emphasize the role of gross factor flows in macroeconomic analysis, see, e.g., Davis and Haltiwanger (1990, 1992), Blanchard and Diamond (1990), Mortensen and Pissarides (1994, 1998), Caballero and Hammour (1994, 1996a), Cole and Rogerson (1996), Ramey and Watson (1997), Den Haan, Ramey and Watson (1997), Campbell and Fisher (1996), Merz (1996). For a thorough analysis and description of microeconomic and aggregate data on job flows, see Davis, Haltiwanger and Schuh (1996).

[2]Those quantities are given precise definitions in section 4.3. See footnote 42.

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the literature on the costs of job loss.[3] That literature attempts to measure the private inefficiency of separations, which yields $V^d > 0$. With no creation-margin distortions ($V^h - c = 0$), the displacement of an individual worker involves the destruction of a job, for a private loss V^d, followed by the creation of a new job, for zero social benefit. If nobody else is affected in the economy, the net social cost is V^d.

Building on this simple accounting exercise, expression (1) highlights two broad sets of issues that play a central role in our analysis and quantitative conclusions. The first concerns social values, and encompasses a number of important dimensions: *(a)* Transactional impediments of a similar nature to those that give rise to privately inefficient separations also give rise to inefficient rents on the creation margin ($V^h - c > 0$). *(b)* Once we consider the possibility of distortions on both margins, the job-loss cost $-V^d$ from worker displacement must be weighed against the new job creation benefit $V^h - c$. If we consider all jobs to be equally valuable ($V^d = V^h$), the net effect is a loss equal to the re-creation cost c. However, there are strong reasons why one expects destruction to be highly "selective" and mostly affect jobs that have turned less valuable. This is particularly true when separations are privately efficient, which means that the private loss in V^d is zero; but is less true of privately inefficient separations. Thus, the degree of private efficiency in separations is a central determinant of the sign of $(V^h - c) - V^d$. *(c)* The displacement of a worker may involve a cost to society that goes beyond the private loss — associated, for example, with the crowding-out of other unemployed workers who are looking for a job. Distortions $V^h - c$ and V^d may therefore involve a purely social component, in addition to private rents. This means in particular that V^d may be positive even if destruction is privately efficient.

The second set of issues concerns aggregate quantity flows and the complexity of their relation to microeconomic experience. In a churning economy, a shock that causes an individual worker to lose a job and then regain another one after a period of unemployment does not necessarily translate *in the aggregate* to a unit-increase in destruction followed by a unit-increase in creation — i.e., integrals of D and H that increase by one unit in expression (1).[4] Unemployment may materialize in a variety of ways. Although we know that, in post-war US manufacturing, the onset of a recession is characterized by a sharp increase in destruction and a milder decline in creation, over time the discounted accumulated responses of destruction and creation may be positive or negative depending one how the economy *recovers*. Recovery could materialize mainly through a sharp (or prolonged) peak

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[3]See, e.g., Topel (1990); Farber (1993); Jacobson, LaLonde, and Sullivan (1993); Anderson and Meyer (1994); Hall (1995).

[4]For simplicity, we ignore the discount factor in this and the next paragraph.

in creation or a sharp (or prolonged) trough in destruction. The former case results in an increase in cumulative reallocation as measured by the integrals of D and H — a phenomenon we call "turbulence"; the latter may possibly result in no change, or in a decrease in cumulative reallocation — a phenomenon we call "chill." This menu of possibilities, and their various combinations, leads to markedly different social costs. As we describe below, post-war evidence from the US manufacturing sector seems to support the case of chill following recessions.

We discuss the model in section 2. An equilibrium framework able to address the kinds of issues raised above must include two main components: on-going creation and destruction decisions (positive H and D); and possible sources of distortions on the creation and destruction margins (non-zero V^h or V^d). To model creative destruction, we assume the revenue of production units to have a stochastic idiosyncratic component which may push them against a destruction margin. Revenue also has a stochastic aggregate component, through which we introduce aggregate shocks. We view major sources of distortions in the two margins as coming from contracting difficulties in the financial and labor markets. This leads us to regard a production unit as the result of a three-party relationship: an entrepreneur who supplies a project and finances part of the required capital through internal funds; a financier who finances the rest through external funds; and a worker who supplies the required labor. The lack of internal funds may constrain creation investment, and create inefficient private rents on that margin. It may also constrain continuation investment, necessary to carry the unit through periods of negative cash flow, and lead to privately inefficient destruction. On the labor side, a rent-component in wages may also give rise to private rents in creation, which segments the labor market and gives rise to unemployment. Moreover, the crowding-out effect of a worker who turns unemployed gives rise to a purely social component in the value of production units.

We rely on empirical studies to constrain our model's implications and anchor our quantitative conclusions. In section 3, we develop a welfare accounting framework that highlights two types of quantities that are central to our analysis and calculations: measures of factor employment and gross flows, and measures of firm and worker rents on the creation and destruction margins. With various degrees of difficulty and reliability, we look for empirical counterparts to those measures to calibrate our model.

In steady state, contractual problems generate substantial welfare costs (7.7 percent of GDP with our preferred parameters), which come in the form of structural unemployment (4.6 percent of GDP) and productivity losses (3.1 percent of GDP). The latter are primarily due to scrambling of the

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productivity ranking of entrants brought about by financial constraints and to technological sclerosis induced by slack in the labor market.

Section 4 explores business cycle aspects of improper churn. We use our calibrated model to match the behavior of unemployment and job flows, and study the cost of recessions. A "theory of recoveries" is essential for a full account of the cost of recessions. We explore different scenarios by which unemployment and productivity losses accumulate following a recession. Both turbulence and chill can arise in our model. We place particular emphasis on the mechanisms that underlie the latter — the selectiveness of creation across productivities and the dynamics of internal funds available for creation — because they are less well understood and find support in the data.

In section 5 we turn to a less structural, empirical study of the cost of recessions. Using simple regressions and semi-structural VARs, we find that, during the period 1972:1-1993:4, US manufacturing typically exhibited a chill in response to "aggregate" shocks and turbulence in response to "reallocation" shocks. The VAR responses we derive for aggregate shocks find a good match in our model. Using shadow social values from the structural model and empirical impulse responses, we calculate the discounted cumulative welfare loss from a recession about the size of the 1974-75 recession. The loss due to unemployment is equivalent to 3.5 percent of GDP and the loss from productivity is 1.4 percent, adding up to a total of 4.9 percent.

Section 6 concludes.

2 Creation, Continuation, and Appropriable Rents

2.1 Entrepreneurs, Workers, and Financiers

The economy we consider has a single consumption good used as a numeraire, which can be transformed one-to-one into a single capital good. It is populated by a continuum of infinitely-lived workers of mass one; and a population of entrepreneur-managers whose structure will be discussed subsequently. The model is set in continuous time. Each worker i is endowed with a unit of labor, and maximizes the expected present value of instantaneous utility

$$c_{it} + z(1 - l_{it}), \quad z \geq 0,$$

linear at any time t in consumption c_{it} and labor supply l_{it}, discounted at rate $\rho > 0$. Entrepreneurs maximize the expected value of consumption, also discounted at rate ρ. As a consequence, all agents are risk neutral, and the market interest rate will be ρ.

Production of the consumption good takes place within infinitesimal *production units*. Those units combine, in fixed proportions, an entrepreneur-

manager, a unit of labor, and κ units of capital. If the entrepreneur does not have sufficient funds to create the unit, he must call upon outside finance provided by a non-resource-consuming competitive sector. Outside finance may also be called upon during the life of a unit, if it goes though a period of negative cash flow. The stake of external financiers is measured by the unit's net external liabilities, b.

The output flow of unit i at time t is

$$\widetilde{y}_t + \nu_i + \widetilde{\epsilon}_{it},$$

where $\widetilde{y}_t$ is a stochastic *aggregate* component; $\nu_i \in [-\overline{\nu}, \overline{\nu}]$ is a fixed *permanent idiosyncratic* component, which, with some abuse of language, we refer to as the unit's "productivity"; and $\widetilde{\epsilon}_{it}$ is a *stochastic idiosyncratic* component that alternates between two states, $\epsilon > 0$ (the "good" state) and $-\epsilon < 0$ (the "bad" state). $\widetilde{\epsilon}_{it}$ transits from one state to the other at probability-rate $\lambda > 0$.

2.2   Contracting Difficulties in the Labor and Financial Markets

We adopt a unified approach to contracting difficulties in factor markets. We assume that a fraction $\phi \in (0, 1]$ of a production unit's capital is *specific*, in the sense that its productive value disappears if either labor or the manager leaves the unit. Specificity with respect to labor and management is intended to capture the edge that such "insiders" may acquire to appropriate quasi-rents within the nexus of the firm.[5] Capital specificity may result from firm-specific human and organizational capital, or from the advantage that a party can gain through government regulation. By itself, specificity may not create a problem if agents' *ex ante* terms of trade can be protected through a fully contingent contract. The difficulty is that such contracts may be highly complex and unenforceable, making it effectively infeasible for agents to precommit not to withhold their human capital from the relationship. In this case, specific quasi-rents must be divided according to the parties' *ex post* terms of trade.[6] Besides active separation decisions, we assume that a production unit fails at rate δ, which causes the manager and labor to separate and specific capital to lose all value.

The non-specific component of capital, $(1 - \phi)\kappa$, has full collateral value, and gives rise to no contracting difficulties. Its owner can withdraw it at any time from the relationship, and use it elsewhere with no loss of value.

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[5]It is clearly a simplification to assume that it is the same fraction of capital that is specific to both labor and management.

[6]For a discussion of this "holdup" problem that results from specificity, see, e.g., Klein, Crawford and Alchian (1978) and Hart (1995, chapter 4). For a discussion of its macroeconomic implications, see Caballero and Hammour (1998a).

We assume it is always leased at a rental cost $r > 0$, which covers the cost of capital adjusted for depreciation.[7] Because the rental cost of generic capital and the marginal utility of leisure are unproblematic, we net them out of production-unit output and define $\widetilde{y}^s \equiv \widetilde{y} - r(1 - \phi)\kappa - z$.

Assuming labor and the entrepreneur cannot precommit not to withhold their human capital from the relationship, how are the associated specific quasi-rents divided? First, we assume that labor and the "owners" of the firm (the entrepreneur and external financiers) transact as two monolithic partners.[8] Assuming continuous-time Nash bargaining, labor obtains, in addition to its outside opportunity cost, a share $\beta \in (0, 1)$ of the present value S of the unit's specific quasi-rents, s_{it}; and the owners obtain a share $(1 - \beta)S$. Denoting by w_t^o labor's flow opportunity cost of participating in a production unit, above the marginal utility of leisure which we also subtract from $\widetilde{y}^s$, the quasi-rents in production unit i are

$$s_{it} = \left(\widetilde{y}_t^s + \nu_i + \widetilde{\epsilon}_{it}\right) - w_t^o.$$

The wage path

$$w_{it} = w_t^o + \beta s_{it} \tag{2}$$

gives the worker a share βS in present value at any point in time. Profits are therefore equal to

$$\pi_{it} \equiv \left(\widetilde{y}_t^s + \nu_i + \widetilde{\epsilon}_{it}\right) - w_{it} = (1 - \beta)\, s_{it}.$$

The above defines profit functions $\pi_{it} = \pi^+(\nu_i; \Omega_t)$ in the good idiosyncratic state and $\pi_{it} = \pi^-(\nu_i; \Omega_t)$ in the bad state, where Ω_t is a state vector that constitutes a sufficient statistic for current and future aggregate conditions (including variables $\widetilde{y}_t^s$ and w_t^o). If the unit has net uncollateralized liabilities b_{it}, the expected present discounted value of profit flows is a function $\Pi^+(b_{it}, \nu_i; \Omega_t)$ when the unit is in the good state and $\Pi^-(b_{it}, \nu_i; \Omega_t)$ when it is in the bad state. Those functions are (weakly) decreasing in b, because,

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[7]This contractual form is not unique. Non-specific capital (call it "land") could also be financed through a fully collateralized loan. The two contracts would be equivalent as long as the value of land remains unchanged, as we have assumed. Otherwise, the question arises why a firm would choose to finance land through debt rather than renting it. The answer may again lie in specificity. If complementary investments are needed that are specific with respect to land, then a rental contract may leave the firm exposed to opportunism by the owners of land (see, e.g., Kiyotaki and Moore 1997, fn. 8, p. 218).

[8]One reason why labor may not be able to deal separately with the entrepreneur and external financiers is informational. The entrepreneur may be able to disguise internal funding in the form of external financing. If, however, labor is able to separate between the two, external liabilities can be used as a way to reduce the rents appropriable by labor. See Bronars and Deere (1991) for a discussion and some empirical evidence.

as we argue below, a higher b generally increases the probability of privately inefficient liquidation. Henceforth, we will replace the argument Ω_t by a time subscript to save on notation.

How are profits divided between the entrepreneur-manager and external financiers? Unlike the manager, financiers cannot threaten to withdraw their human capital from the production unit. Thus, they will be unwilling to provide any financing for specific capital without an effective contractual claim over the unit's cash flow. A financial contract in this context can be thought of as a senior *uncollateralized* claim b over the unit's cash flow, with a preferred return equal to the risk-adjusted opportunity cost of funds. Such a contract reduces but does not eliminate financial constraints. Since the entrepreneur-manager can always threaten to withdraw his human capital, he can attempt to renegotiate with the financier. Assuming that Nash bargaining would give the manager a share $\alpha \in (0,1)$ of Π, any external claim above $(1-\alpha)\Pi$ will be renegotiated down. This puts an upper-bound on the external claims a production unit can support.[9]

If a positive value of b denotes a positive net *external* liability of the production unit, it is practical to use a negative value of b to denote, by extension, situations where a production unit has positive net *internal* funds. This can happen either because the entrepreneur's wealth was greater than $\phi\kappa$ at the time of creation, or because the unit has already paid back all its liabilities. The fact that Π^+ and Π^- are decreasing functions of b applies to negative as well as positive values of b, because large internal-funds reserves decrease the probability of inefficient liquidation in the bad state. By the same argument, an optimal policy for the entrepreneur that minimizes the risk of inefficient liquidation is not to consume dividends until the production unit fails or is liquidated.[10] In particular, this implies that net liabilities will be repaid at the fastest possible rate.

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[9]The contractual form the two parties can rely on to minimize the financial constraint is not unique. Under our assumptions, one can show that there are other — more equity-like — contracts that are capable of achieving the same outcome, in terms of investment decisions and net transfers between the two parties. Our model does not distinguish between different institutional arrangements, as long as the following properties are satisfied: *(i)* the financier expects to get his money back in present value; *(ii)* the re-negotiation constraint is not violated; *(iii)* the entrepreneur only consumes from the project's cash flow after the financier's claim has been fully paid.

[10]This statement must be qualified by the observation that, as long as the aggregate variable $\tilde{y}$ has finite support, there is a level $b^{safe} < 0$ of internal funds beyond which the production unit is immune from inefficient liquidation. This happens when the interest income ρb^{safe} on internal funds covers any possible negative cash flow π^- in the bad state. Beyond b^{safe}, the entrepreneur is indifferent between consuming dividends or not.

2.3 Creation and Continuation

A production unit requires specific investment $\phi\kappa$ for its creation. It may also require investment to cover periods of negative cash flow. The purpose of such "continuation" investment is to hoard the unit's specific assets. Continuation investment is therefore, by its very nature, fully specific.

Suppose an entrepreneur with wealth a has a project for a production unit with productivity ν, known ex ante. We assume a project is always started in the good idiosyncratic state. To create the unit, the entrepreneur needs to incur a net liability $b = \phi\kappa - a$ (if b is negative, he will be left with positive internal funds). The project will be undertaken under two conditions. First, it must be profitable:

$$\phi\kappa \leq \Pi_t^+ (b, \nu). \tag{3}$$

Second, the entrepreneur must be able to attract the required financing for the project. We have seen that the maximum liability a project can bear is

$$b \leq (1 - \alpha)\Pi_t^+(b, \nu). \tag{4}$$

Since Π^+ is decreasing in b, constraints (3) and (4) can be rewritten as

$$\phi\kappa - a \leq \overline{b}_t^+(\nu) \equiv \min\{\overline{b}_t^{p+}(\nu), \overline{b}_t^{f+}(\nu)\}, \tag{5}$$

where $\overline{b}_t^p$ is defined implicitly by taking the *profitability constraint* with equality, and $\overline{b}_t^f$ is defined by taking the *financial constraint* with equality (either variable can take value $+\infty$ when the constraint is not binding).[11] Figure 2.1(a) illustrates the operation of the profitability and financial constraints on the creation of projects with productivities ν_1 and ν_2, $\nu_1 < \nu_2$. For projects with productivity ν_1, it is the profitability constraint $b \leq \overline{b}^{p+}(\nu_1)$ that is binding; while for projects with productivity ν_2, it is the financial constraint $b \leq \overline{b}^{f+}(\nu_2)$.

Once a production unit has been created, it may still require further investment in periods of negative cash flow. We restrict ourselves to a range of parameters such that production units' profits are positive in the good state and negative in the bad state: $\pi_t^+(\nu) > 0$ and $\pi_t^-(\nu) < 0$. If the negative cash flow in the bad state is not covered, labor must be laid off and the specific capital in the production unit is lost.

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[11]It is important to realize that the dichotomy between the profitability constraint $\overline{b}_t^{p+}$ and the financial constraint $\overline{b}_t^{f+}$ is less sharp than it may appear. The profitability constraint takes account of the possibility of a future financial constraint: the possibility of inefficient liquidation, that lowers the value Π_t^+ of highly leveraged units. This possibility may make the creation of highly leveraged units unattractive, even when entrepreneurs who have the wealth to create well-capitalized units find entry attractive.
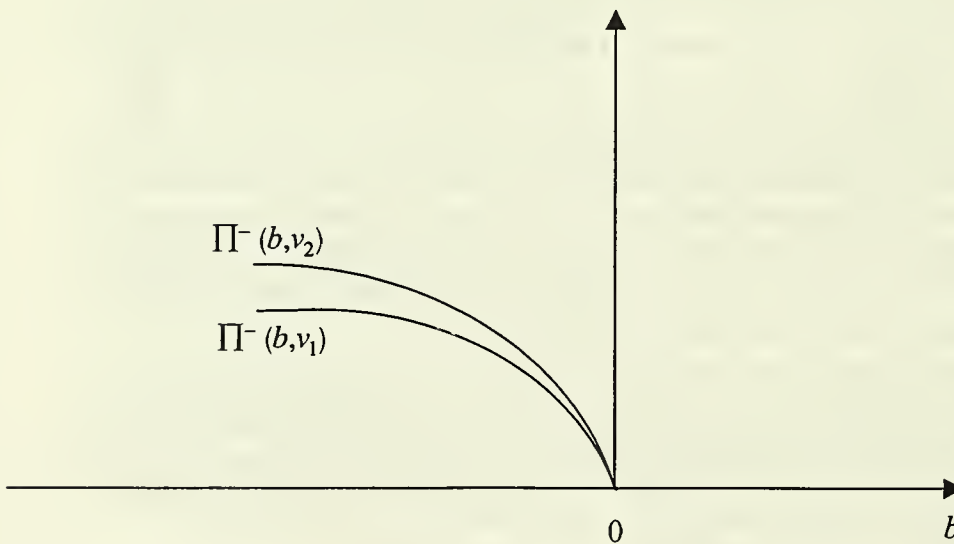
Figure 2.1

Constraints on Creation and Continuation

(a) Creation Investment
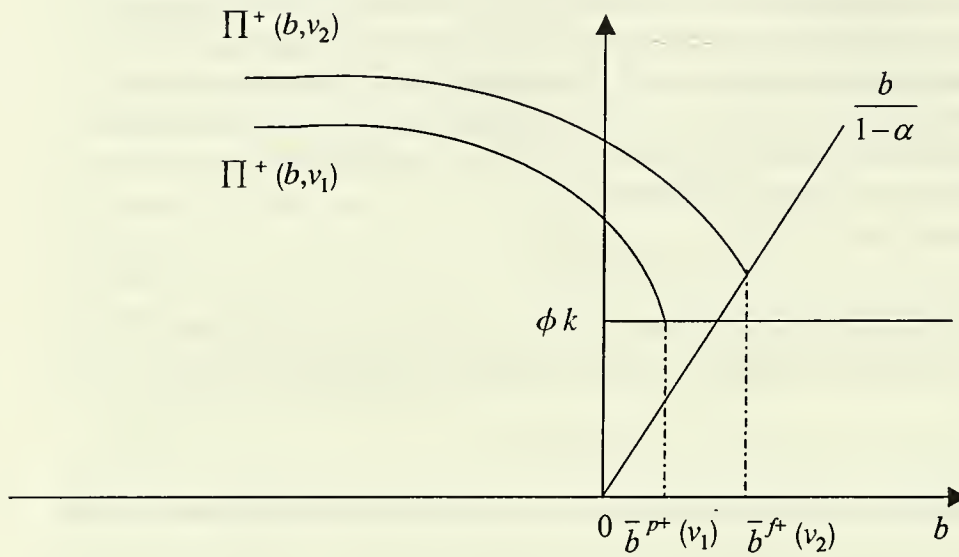
(b) Continuation Investment

Continuation investment faces profitability and financing constraints, $\bar{b}_t^{p-}(\nu)$ and $\bar{b}_t^{f-}(\nu)$, similar to the constraints on creation. Consider first a unit in the bad state with no internal funds to cover its negative cash flow ($b \geq 0$). That unit may have to interrupt its operations due to a financing constraint, even though continuation may be desirable. This can be illustrated most easily in a steady-state setting, where aggregate conditions Ω are invariant. In the absence of financing constraints (i.e., taking the limit $b \to -\infty$), one can show that the value of the option to cover negative cash flows in the bad state is

$$\frac{\pi^-(\nu) + \lambda \Pi^+(-\infty, \nu)}{\rho + \delta + \lambda}. \tag{6}$$

However, because the manager would renegotiate the debt down to $\bar{b}^{f+}(\nu) = (1-\alpha)\Pi^+\left(\bar{b}^{f+}(\nu), \nu\right)$ once in the good state, one can show that the value to the financier of the option to finance negative cash flows is no greater than

$$\frac{\pi^-(\nu) + \lambda(1-\alpha)\Pi^+\left(\bar{b}^{f+}(\nu), \nu\right)}{\rho + \delta + \lambda},$$

which is obviously smaller than the private value (6) of continuation.

It is therefore possible for *privately inefficient liquidation* to take place, where continuation has positive present value but cannot be financed externally.[12] One can further show that if the entrepreneur is able to attract external finance for continuation, he will be able to do so irrespective of the current level of $b \geq 0$.[13,14] In other words, $\bar{b}^{f-}(\nu)$ can take only two values: 0 or

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[12]Conceivably, the financier may offer the entrepreneur an "insurance" arrangement through which he commits to finance negative cash flows in the bad state in exchange for an insurance premium paid in the good state. With large enough cash flows in the good state, the financier may be able to break even. However, insurance gives rise to an informational problem if the financier cannot observe the unit's idiosyncratic state. The entrepreneur need only claim to be in the bad state to collect the insurance. The informational problem is less severe under a simple liability arrangement, where the entrepreneur must liquidate his production unit to discontinue payments to the financier.

[13]Consider two non-negative levels of external liability, $b_{\text{high}} > b_{\text{low}} \geq 0$. If the financier is willing to finance continuation at b_{low}, he has all the more reason to finance it at b_{high}, since his return in that case can only be greater. Conversely, if continuation is financed at b_{high}, the entrepreneur can always find an interest rate path that will attract finance at b_{low}. One such path is to increase the liability instantly to b_{high}, at which level we know that external finance can be induced. This path is preferable for the entrepreneur to inefficient liquidation, although he generally has more favorable alternative paths.

[14]When a privately inefficient separation takes place, both the entrepreneur and labor lose their share of the production unit's surplus $S_t^-(b, \nu)$. Could labor come to the rescue by taking a wage cut? In the continuous-time Nash bargaining solution behind wage equation (2), labor and the entrepreneur get or contribute their share — β and $(1-\beta)$ — of the flow surplus s_t. But if the entrepreneur runs out of internal funds in the bad state,

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$-\infty$. The interesting case for us is when continuation in the bad state cannot be financed. We therefore restrict ourselves to cases where negative cash flows in the bad state are large enough, so that the finance constraint on continuation is always binding:

$$\overline{b}_t^{f-}(\nu) = 0, \quad \nu \in [-\overline{\nu}, \overline{\nu}], \, t \geq 0.$$

Consider now a unit in the bad state that still has internal funds ($b < 0$), which can be used to cover negative cash flows. The profitability constraint for continuation is

$$\Pi_t^-(b, \nu) \geq 0,$$

which leads us to define $\overline{b}_t^{p-}(\nu)$ as the lowest value of b for which $\Pi_t^-(b, \nu) = 0$. One can show that, in steady state, $\overline{b}_t^{p-}$ also takes only two values: 0 or $-\infty$.[15] In other words, if a unit has internal funds and transits to the bad state, it either continues until forced to exit when b reaches $\overline{b}_t^{f-} = 0$; or it exits voluntarily upon transiting into the bad state, irrespective of its level of b. In the former scenario, the unit is financially constrained; in the latter, it is profitability constrained. The financial constraint on

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and is unable to finance his share of the negative surplus, the Nash bargaining problem becomes constrained and the above solution breaks down. It may make sense for the worker, in that case, to finance the whole of $s_t^-(\nu)$ in the bad state in order to retain his share $\beta S_t^+(b, \nu)$ in the good state. The steady-state condition for this to happen is

$$s_t^-(\nu) + \lambda \beta S_t^+(-\infty, \nu) > 0.$$

On the other hand, the condition for continuation to be privately efficient is

$$s_t^-(\nu) + \lambda S_t^+(-\infty, \nu) > 0.$$

It is therefore clear that financing may not be worth it for labor, even when continuation is privately efficient. In other words, the manager-owner may be subject to a financing constraint with respect to the worker, similar to that with respect to an external financier. We assume that parameters are such that this worker-financing constraint is always binding.

[15]The argument why, generically, $\overline{b}^{p-}(\nu) \in \{-\infty, 0\}$ in steady state is as follows. Let $\overline{\nu}^d$ be the level of productivity at which a unit with infinite funds ($b = -\infty$) is indifferent between continuing or liquidating in the bad state, i.e. $\pi^-(\overline{\nu}^d) + \lambda \Pi^+(-\infty, \overline{\nu}^d) = 0$. (i) When $\nu = \overline{\nu}^d$, the value Π^- of a unit in the bad state is zero, irrespective of its level of b; which implies that its value Π^+ in the good state is also independent of b. Thus, any unit in the bad state will also find that $\pi^-(\overline{\nu}^d) + \lambda \Pi^+(b, \overline{\nu}^d) = 0$ irrespective of b, and will be indifferent between continuation and liquidation. (ii) When $\nu < \overline{\nu}^d$, it is clear that continuation is undesirable for any unit in the bad state, irrespective of the level of b. (iii) When $\nu > \overline{\nu}^d$, continuation is strictly desirable irrespective of b for any unit in the bad state, because it must be strictly more desirable than in the case $\nu = \overline{\nu}^d$. From all of the above, one concludes that, generically, $\overline{b}^{p-}(\nu)$ takes either value $-\infty$ (when $\nu < \overline{\nu}^d$) or 0 (when $\nu > \overline{\nu}^d$).

continuation is illustrated in figure 2.1(b), where both production units are financially constrained in the bad state.

Because we have assumed no common ownership of production units in our model, a literal interpretation of privately inefficient separations is in terms of bankruptcy. This interpretation can be loosely extended to partial liquidations of a firm's activities because of limited funds. If an entrepreneur were allowed to operate several production units at a time, which effectively share in the same pool of liabilities or internal funds, financial constraints may lead him to inefficiently liquidate some units but not others. Because of the complexity involved, this is not an avenue we pursue.

Having restricted ourselves to the case where negative cash flows cannot be financed externally in the bad state, we can now specify the required risk-adjusted return on external liabilities. The dynamics of b are given by:[16]

$$\dot{b}_t = \begin{cases} (\rho + \delta + \lambda)\, b_t - \pi_t, & b_t > 0; \\ \rho b_t - \pi_t, & b_t \leq 0. \end{cases}$$

With positive external liabilities ($b_t > 0$) — which, by assumption, only happens in the good state — the external financier requires a return $\rho + \delta + \lambda$ to cover the opportunity cost ρ of capital as well as the probability $\delta + \lambda$ of failure or bad-state liquidation. With positive internal funds ($b_t < 0$), the entrepreneur earns the interest rate ρ.

2.4 General Equilibrium

We now turn to considerations needed to close the model in general equilibrium. In order to keep track of units created over time, we denote by $n_t^+(b, \nu)$ the density of units in the good state with external liability b and permanent productivity ν; and by $n_t^-(b, \nu)$ the equivalent density of units in the bad state. Thus, the total number of units in the good and the bad state are

$$N_t^+ = \int_{-\bar{\nu}}^{\bar{\nu}} \int_{-\infty}^{\phi\kappa} n_t^+(b, \nu)\, db\, d\nu \quad \text{and} \quad N_t^- = \int_{-\bar{\nu}}^{\bar{\nu}} \int_{-\infty}^{\phi\kappa} n_t^-(b, \nu)\, db\, d\nu,$$

respectively. Total employment is $N_t = N_t^+ + N_t^-$ and unemployment is $U_t = 1 - N_t$. Aggregate output is

$$Y_t \equiv \int_{-\bar{\nu}}^{\bar{\nu}} \int_{-\infty}^{\phi\kappa} \left[(\tilde{y}_t + \nu + \epsilon)\, n_t^+(b, \nu) + (\tilde{y}_t + \nu - \epsilon)\, n_t^-(b, \nu) \right] db\, d\nu.$$

What is the source of new projects? At any point in time, we assume a continuum of non-active entrepreneurs denoted by i, each of whom has

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[16]We follow the convention of denoting the time-derivative of a function $x(t)$ by $\dot{x} \equiv dx/dt$.

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wealth a_i and a project for a production unit with productivity ν_i. The project has therefore a financing requirement of $b_i = \phi\kappa - a_i$ (where $b_i < 0$ indicates a unit that starts with positive internal funds). In the cross section, the distributions of project productivities and wealth are independent. The marginal density of project productivities is $f(\nu)$, $\nu \in [-\overline{\nu}, \overline{\nu}]$. The distribution of wealth can be specified directly in terms of the marginal density $g(b; A_t)$ of project financing requirements, where A_t is an index of the aggregate wealth of non-active entrepreneurs.[17] In order to avoid modeling the detailed population dynamics of potential entrepreneurs, we assume there is an arbitrary process by which potential entrepreneurs invent or lose ideas for projects that gives us the above distributions. We work with two cases for the dynamics of A_t: *(i)* A_t is constant over time; *(ii)* A_t follows a process designed to capture the effect of aggregate conditions $\widetilde{y}_t$ on the internal funds available for creation:

$$\dot{A}_t = \psi(\widetilde{y}_t, A_t), \quad \psi_1 \geq 0, \ \psi_2 \leq 0. \tag{7}$$

Given the above distributions, we can calculate the creation rate of production units at any point in time. For each productivity ν, we have seen that there is minimum wealth compatible with creation constraints (5) — which translates into an upper-bound $b \leq \overline{b}_t^+(\nu)$ on initial leverage. We define $\underline{\nu}_t^c$ as the productivity at which an entrepreneur with infinite funds would be indifferent between creating or not. Total gross creation is

$$H_t = \int_{\underline{\nu}_t^c}^{\overline{\nu}} \int_{-\infty}^{\overline{b}_t^+(\nu)} g(b; A_t) f(\nu) \, db \, d\nu.$$

The number D_t of production units destroyed at any point in time is made up of three components:

$$D_t = D_t^\delta + D_t^e + D_t^f,$$

where

$$
\begin{aligned}
D_t^\delta &= \delta(1 - U_t); \\
D_t^s &= \lambda \int_{-\overline{\nu}}^{\overline{\nu}_t^d} \int_{-\infty}^{\phi\kappa} n_t^+(b, \nu) \, db \, d\nu + \max\{\dot{\overline{\nu}}_t^d, 0\} \int_{-\infty}^{0} n_t^-(b, \nu_t^d) \, db; \\
D_t^f &= \lambda \int_{\overline{\nu}_t^d}^{\overline{\nu}} \int_{0}^{\phi\kappa} n_t^+(b, \nu) \, db \, d\nu + \int_{-\overline{\nu}}^{\overline{\nu}} n_t^-(0, \nu) \, \dot{b}_t \Big|_{(b, \widetilde{\epsilon})=(0, -\epsilon)} \, d\nu.
\end{aligned}
$$

The three terms correspond, respectively, to "passive," "privately efficient" (or "Schumpeterian") destruction, and "privately inefficient" (or "spurious")

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[17]Since the distribution of wealth is the primitive, the derived density $g(b; A_t)$ shifts laterally with changes in the creation cost $\phi\kappa$.

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destruction. *(i)* Passive destruction, D_t^δ, captures the flow of units that fail for *exogenous* reasons. *(ii)* Privately efficient (or Schumpeterian) destruction D^s captures units destroyed because they hit a *profitability* constraint on continuation. Define $\bar{\nu}_t^d$ as the level of profitability at which a unit with infinite internal funds would be indifferent between continuing or not in the bad state. The first term captures units that turn unprofitable because they enter the bad state with productivity $\nu \leq \bar{\nu}_t^d$; the second, units that turn unprofitable because they cross that threshold while in the bad state due to deteriorating aggregate conditions. This type of destruction is a form of Schumpeterian destruction, by which unproductive components of the economy's productive structure are renovated.[18] *(iii)* Privately inefficient (or spurious) destruction, D_t^f, measures destruction due to *financial* constraints. The first term in D_t^f is the flow of units that turn bad and must be liquidated because of insufficient capitalization; the second term captures the flow of units in the bad state that run out of internal funds.[19]

Finally, we determine the equilibrium opportunity-cost of labor in order to close the labor market:[20]

$$w_t^o = \frac{H_t}{U_t}\beta E_\nu[S_t]. \tag{8}$$

It is equal to the rate H_t/U_t at which an unemployed worker expects to find employment, multiplied by the share $\beta E_\nu[S_t]$ he expects to obtain of the surplus from his new job.[21] The expected quasi-rents in a future job are equal to

$$E_\nu[S_t] = \frac{1}{1-\beta}\int_{-\bar{\nu}}^{\bar{\nu}}\int_{-\infty}^{\bar{b}_t^+(\nu)}\Pi_t^+(b,\nu)\frac{g(b;A_t)f(\nu)}{H_t}\,db\,d\nu.$$

3   Improper Churn: Social Cost Accounting

In this section, we calibrate the model's parameters and use it to analyze the functioning of the economy in steady state. We pay particular attention

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[18]This is a rather simplistic view of Schumpeterian destruction. See, e.g., Caballero and Hammour (1994) for a vintage model of creative destruction. In contrasting Schumpeterian with spurious destruction, we do not mean to attribute to Schumpeter the view that separations are privately efficient. What we attribute to him is the view — central, for example, to his "liquidationist" theory of recessions — that destruction is highly selective (see De Long 1990).

[19]All else being equal, the lower a unit's productivity, the more likely it is to be liquidated due to financial constraints. This "selectivity" of spurious destruction makes the difference with Schumpeterian destruction less stark than may appear at first glance.

[20]Recall that this opportunity-cost of labor is net of the value of leisure.

[21]For a formal derivation of expression (8), see the appendix to Caballero and Hammour (1998b).

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to the disruptions that transactional impediments can cause to the churn process, and quantify their costs within a social cost accounting framework. The next section addresses similar issues in a business cycle context.

3.1 An Accounting Framework

The welfare costs of improper churn appear along several dimensions. In order to uncover those mechanisms we assume the economy is in steady state, with a constant $\tilde{y} = \bar{y}$, and write aggregate flow-welfare as

$$\mathcal{W} = Y^s - \phi \kappa H,$$

where $Y^s \equiv Y - r(1 - \phi)\kappa N - zN$ measures aggregate output *net* of the return on generic capital and the foregone utility of leisure.[22] Steady-state welfare, being the difference between net output and creation costs, can be affected by contractual impediments through three main channels: *(i)* a change in the level of *employment*, and hence the level of net output for given labor productivity; *(ii)* a change in the average *productivity* of each employed worker; and *(iii)* a change in the rate of *investment* and its cost.

Labor productivity is itself determined by the *level* and *composition* of the underlying churn. To see this, consider a unit-difference in the steady-state churn rate across two economies. In flow terms, the faster churning economy destroys per unit-time an additional production unit with average flow-value c^d, and creates an additional unit with flow-value c^h (flow-values will be defined more precisely below). The net effect is a productivity upgrading $(c^h - c^d)$, which is counterbalanced by the flow-cost $\delta \phi \kappa$ of recreating a job. In addition to this level effect, productivity is affected by the composition of the churn. In an economy that has a relatively large spurious component of the churn, for example, the flow-value c^d of units on the destruction margin will be high, which means low productivity upgrading $(c^h - c^d)$.[23]

More formally, rewrite flow-welfare $\mathcal{W}$ as

$$\mathcal{W} = y^s N + \int_{-\bar{\nu}}^{\bar{\nu}} \tilde{\nu}(n_\nu^+(\tilde{\nu}) + n_\nu^-(\tilde{\nu}))d\tilde{\nu} + \epsilon(N^+ - N^-) - \phi \kappa H.$$

To compare any steady-state variable X with its efficient-economy counterpart X^*, we define $\widehat{X} \equiv X - X^*$. As we have seen, $\widehat{\mathcal{W}}$ can be decomposed into an unemployment, a productivity, and a creation-cost term, with the productivity term being itself a function of the level and composition of

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[22]Naturally, aggregate welfare measures allow us to make statements about efficiency, not about distributional issues.

[23]This statement is true for a given value of c^h. There are good reasons to believe, however, that the same factors responsible for tight financing obstacles to continuation (large c^d) are likely to be responsible for financing obstacles to continuation (large c^h).

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the churn. Because a lower churn rate both reduces productivity and the re-creation cost, we net the latter out of the former and construct a net productivity term. Moreover, since δ-destruction is fully a function of U, we attribute any net productivity effects of changes in this passive component of the churn to the unemployment term, and measure the "active" churn in steady state as

$$D^s + D^f = H - \delta(1 - U).$$

The resulting decomposition is

$$
\begin{aligned}
\widehat{\mathcal{W}} \;=\; & -\left[c^h - \delta\phi\kappa\right]\widehat{U} \\
& + \left[c^h - c^{ds} - \delta\phi\kappa\right]\frac{\widehat{D^s} + \widehat{D^f}}{\delta} \\
& - \left[c^{df} - c^{ds}\right]\frac{\widehat{D^f}}{\delta} \\
& + \left[\widehat{c}^h\frac{H^*}{\delta} - \widehat{c}^{ds}\frac{D^{s*}}{\delta}\right];
\end{aligned}
\tag{9}
$$

where

$$
\begin{aligned}
c^h \;&\equiv\; y^s + \nu^h + \frac{\delta\epsilon}{\delta + 2\lambda}; \\
c^{ds} \;&\equiv\; y^s + \nu^{ds} - \frac{\delta\epsilon}{\delta + 2\lambda}; \\
c^{df} \;&\equiv\; y^s + \nu^{df} - \frac{\delta\epsilon}{\delta + 2\lambda};
\end{aligned}
$$

and

$$\nu^x \equiv \int_{-\bar{\nu}}^{\bar{\nu}} \frac{x(\nu)}{X}\nu d\nu, \quad X \in \{H, D^s, D^f\}.$$

The term on the first line in (9) represents the unemployment effect, adjusted for the associated reduction in the passive component of the churn.[24] The expressions on the next three lines represent the net productivity effect. It is made up of a level effect of active destruction $\widehat{D^s} + \widehat{D^f}$ based on the shadow value of privately efficient destruction (the second line), an additional effect due to the private inefficiency of spurious destruction $\widehat{D^f}$ (the third line), as well as additional compositional effects associated with the selection of productivities created or destroyed along each margin (the fourth line).

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[24]The gross effect of higher unemployment is $-c^n\widehat{U}$, based on c^n for an average unit in the economy. From this we net out the implied welfare effect $[(c^h - c^n) - \delta\phi\kappa]\widehat{D}^\delta/\delta$ of the reduction $\widehat{D}^\delta = -\delta\widehat{U}$ in δ-destruction, and obtain the expression $-\left[c^h - \delta\phi\kappa\right]\widehat{U}$.

3.2 Parameter Choice

We can now turn to the choice of parameter values that allows us to quantify our model. Nine parameters characterize technological and demand aspects: ρ, r, $\tilde{y}$, κ, ϕ, ϵ, z, δ, λ; two characterize institutional aspects: α and β; and the distribution of projects adds another three parameters: it is assumed to have total mass A, with project productivities uniformly distributed on the interval $[-\overline{\nu}, \overline{\nu}]$ and financing requirements uniformly distributed on $[0, b^{\max}]$.[25] Throughout this section, we assume the mass A to be exogenously given. Table 1 summarizes the values we chose for the above parameters, based on observed features of the US economy. A number of those parameters were calibrated by fitting quantities that arise endogenously within our model. Although this amounts to a simultaneous equations exercise, it will be intuitive to think of it in terms of the assignment of one parameter for each fitted quantity.

Table 1: Model Parameters

Parameter	Value	Parameter	Value
ρ	0.060	ϕ	0.329
r	0.135	ϵ	0.283
$\overline{y}$	0.899	z	0.000
κ	1.940	$b^{\max}$	0.394
α	0.700	δ	0.060
$\overline{\nu}$	0.106	λ	0.205
β	0.333	A	0.254

Calibration of the first six parameters is relatively straightforward. *(i)* The interest rate was set to $\rho = 0.06$. *(ii)* The gross rental-cost of generic capital was set to $r = 0.135$. Given the interest rate, this means a depreciation rate of 7.5 percent, which falls between the rates of depreciation of structures and equipment (source: BEA). *(iii)* The aggregate component $\overline{y}$ of production-unit output was chosen in such a way as to normalize aggregate output to one. *(iv)* The capital requirement of a production unit was set to $\kappa = 1.94$, which is the value needed to match the observed capital/output ratio (equal to 1.9 for the US business sector in 1995; source: OECD).[26] *(v)* Entrepreneurs' share parameter α determines the return premium on internal funds, and hence the economy's profit rate. We set it

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[25] By definition, $b^{\max}$ must satisfy the constraint $b^{\max} \leq \phi\kappa$.

[26] One must distinguish between the amount of capital actually utilized in production units, and capital as measured using national accounts perpetual inventory procedures. In our case, since the separation rate is higher than the depreciation rate of generic capital, the former stock of capital is less than the latter. Our calibrations are aimed at matching measured capital.

to the value $\alpha = 0.7$ that yields a profit rate of 15 percent. *(vi)* For the dispersion of project productivities, we set $\bar{\nu} = 0.106$. This corresponds to ± 10 percent of average productivity.

The remaining eight parameters determine the shadow values and quantities highlighted in equation (9). We anchor the shadow values in this equation using various literatures that attempt to measure private rents on the creation and destruction margins. The flow value $(c^h - c^{ds} - \delta\phi\kappa)$ essentially captures private rents on the creation margin, and $(c^{df} - c^{ds})$ captures private rents on the spurious destruction margin. Creation rents are attributable to two factors: labor and the firm's standing in terms of internal funds and productivity. *(i)* Abowd and Lemieux (1993) estimate the equivalent of labor's share β of rents to fall in the range [0.23,0.39].[27] Using a value of $\beta = 1/3$ for labor's bargaining share, we obtain an average rent component of wages equal to 8 percent of the average wage. *(ii)* Alderson and Betker (1995) estimate the liquidation value of a firm to be about 2/3 of firm assets. This leads us to set the capital specificity parameter ϕ to about 1/3, which results in an average flow rent on the firm's side equivalent to 6 percent of the average wage. *(iii)* On the destruction side, privately inefficient separations can cause rent losses to labor and to the firm. The literature includes a wide range of estimates for the cost of job loss, that range from less than 2 weeks of wages to substantially more than a year.[28] Using unemployment insurance data, Anderson and Meyer (1994) estimate an average worker loss of 14 weeks of wages. Although this is an estimated average over all permanent separations — including privately efficient ones — we apply it conservatively to the privately inefficient component of separations D^f.[29] The literature on the firm side is much less developed. Hamermesh (1993, pp. 207-209) surveys various estimates, with again a wide range that goes from 3 weeks to 2.5 years of a worker's wage depending on characteristics of the firm. We use the estimate of 20 weeks of wages from one of the more careful studies (Button 1990). The total loss of 34 weeks for the whole production unit is obtained by choosing a value $\epsilon = 0.283$, that determines the output gap between the good and the bad state.

The quantities in equation (9) are U, H, and the different types of destruction, both in the calibrated economy and its efficient counterpart. *(iv)* We use the variable z to calibrate the unemployment rate to $U = 0.06$. The resulting value is very small, which leads us to set $z = 0$.[30] *(v)* We calibrate

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[27]See Oswald (1996) for a survey of the related literature.

[28]See, e.g., Ruhm (1987), Topel (1990), Farber (1993), Jacobson, LaLonde and Sullivan (1993), and Whelan (1997).

[29]In fact, the median loss is of only about one week of wages while about 9 percent of workers suffer a loss of more than a year.

[30]As a result, the social cost $(c^h - \delta\phi\kappa)$ of unemployment in equation (9) includes the full marginal wage. Given the wage, the cost would be higher if unemployment is associated

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the annual churn rate to $H/(1 - U) = 0.11$ by choosing the appropriate width $b^{\max}$ for the distribution of financing requirements.[31] *(vi)* On the destruction side, the churn rate translates into three types of destruction: $H = \delta(1 - U) + D^f + D^s$. We set the failure rate of production units to $\delta = 0.06$ to determine the first type, chosen in the lower range of values compatible with the parameter restrictions we impose in section 2. *(vii)* Using the Poisson parameter λ, we set the annual rate of privately inefficient separations D^f to about 2.5 percent of employment, which corresponds to the annualized rate of "displacements" as reported by the Displaced Workers Survey for the period 1991-93.[32] *(viii)* The churn rate in the corresponding efficient economy — for which we have no observable counterparts — is much more difficult to anchor, since this requires assumptions about unobserved relationships.[33] In our model, it is principally determined by the mass A of potential projects. In the absence of any solid anchor, we chose a rather arbitrary value for A in the middle of its admissible range that generated an efficient churn rate $H^* = 0.185$. To get an idea of the sensitivity of our social-welfare calculation to this parameter, consider the experiment of adding mass to the $g(b)$ distribution at the right of $b^{\max}$ — in such a way as to increase the efficient churn rate without affecting the inefficient economy. An addition of mass that increases H^* by 0.01 increases the welfare cost of inefficiency reported in the next sub-section by 0.3 percent of calibrated GDP.

3.3 Structural Unemployment, Sclerosis, and Scrambling

Based on the parameters chosen in the previous sub-section, table 2 quantifies the economy's deviation from efficient equilibrium . It presents results for the α-economy, that adds only the financial constraint to the efficient economy ($\alpha > 0$, $\beta = 0$); the β-economy, that adds only the labor market problem ($\beta > 0$, $\alpha = 0$); and the $\alpha\beta$-economy ($\alpha, \beta > 0$), that adds both problems. The table reports the three basic determinants of welfare: unem-

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with deteriorating human capital, social stigma, etc.; and lower if work is associated with a disutility.

[31] This gross churn rate is an average value between a sectoral measure of flows in US manufacturing and an economy-wide measure of flows limited to the state of Pennsylvania (see Davis, Haltiwanger and Schuh 1996, p. 21).

[32] See Hall (1995), table 1, p. 232. This survey was conducted in 1994 and asked whether the respondent had lost a job during the 1991-93 period for plant closing, an abolished shift, insufficient work, or similar reasons. Hall points out that a separation is "more likely to be considered a displacement in a retrospective survey if it has larger personal consequences."

[33] This is always the case with out-of-sample analysis. Estimating the impact of removing a tax in a market that has had it for a long time, for example, requires assumptions about segments of supply and demand curves that have not been observed.

ployment, average labor productivity, and creation. It also reports measures of destruction and of the shadow wage. Compared to the efficient economy, welfare in the $\alpha\beta$-economy suffers from a 6 percentage-point increase in the unemployment rate and average productivity lower by 8 percent. Those costs are partly alleviated by a reduction in job-creation costs, given the economy's substantially lower churn rate.

Table 2: Steady-State Equilibrium

	Efficient Economy	α-economy	β-economy	$\alpha\beta$-economy
U	-	-	0.049	0.060
Y^s/N	0.960	0.947	0.886	0.884
H	0.185	0.177	0.094	0.104
D^s	0.125	0.101	0.037	0.024
D^f	-	0.015	-	0.023
w^o	0.745	0.737	0.725	0.697

Table 3 quantifies the social-cost decomposition in (9) for our chosen parameters. The "unemployment," "churn," "spurious destruction," and "selection" effects, respectively, correspond to the four lines in equation (9). Note that, because gross aggregate output was normalized to one, welfare effects can be interpreted as a percentage of GDP in the $\alpha\beta$-economy steady state. The welfare costs of improper churn can be significant: the unemployment cost in table 3 is 4.6 percent of GDP and the net productivity cost of inefficient churn is another 3.1 percent, which adds up to a total cost of 7.7 percent.

Table 3: Steady-State Welfare Effects

	α-economy	β-economy	$\alpha\beta$-economy
Unemployment	-	-0.039	-0.046
Churn	-0.008	-0.079	-0.099
Spurious Destruction	-0.020	-	-0.022
Selection	0.021	0.058	0.090
Productivity	-0.007	-0.021	-0.031
Total	-0.007	-0.060	-0.077

The unemployment cost of improper churn in table 3 is large. Unemployment rises to 4.9% due to the labor-market problem, and to 6.0% when we add financial constraints (table 2). "Structural" unemployment in steady state is intimately tied to a churn process that faces impediments in the labor market. In the absence of either a churn (i.e., if $\delta = \lambda = 0$) or labor-market impediments (if $\beta = 0$), steady-state unemployment would be zero. Financial constraints compound with those two factors to cause even higher unemployment.[34]

Unemployment can be thought of as a response of the economic system that restores equilibrium in the presence of wage rents. Compared to an efficient steady state with full employment, we have seen that contracting impediments in the labor market give rise to wage rents, which break the efficient free-entry condition on the creation margin. Lower creation and higher unemployment are an endogenous response of the economic system. They lead to higher unemployment duration U/H, which reduces labor's outside opportunity cost w^o (see equation 8). This offsets rent appropriation, and helps guarantee the rate of return required by capital markets. Note, however, that although the shadow wage w^o falls, this is not generally true of actual wages inclusive of the rent component.[35]

Table 2 shows that financial constraints compound with labor-market constraints to further increase the structural rate of unemployment, which

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[34]Our calculation does not take into account positive efficient unemployment due to search. This tends to exaggerate our unemployment costs. On the other hand, transactional impediments generate an under-employment problem that generally extends beyond what is captured by unemployment statistics, and affects both the sectoral composition of employment and the participation rate. This is not taken into account by our calculation either.

[35]See Caballero and Hammour (1998b).

adds 0.7 percent of GDP to its social cost. This happens as financial constraints reduce the steady-state demand for labor, both because of the financial restrictions on creation and because the profitability of hiring is reduced by the risk of inefficient liquidation.

In addition to unemployment, the economy suffers from a substantial churn cost. The inefficiency of the churn is characterized by a combination of "sclerosis" and "scrambling," i.e. a slower and less effective churn. Both labor-market and financial-market problems create *sclerosis* — the survival of production units that would not survive in an efficient equilibrium. As illustrated in table 2, sclerosis arises through the low shadow wage w^o associated with lax labor-market conditions (high unemployment). This reduces the pressure to scrap low-productivity units in the bad state, and reduces the threshold productivity $\underline{\nu}^d$ at which this is done. The result is a substantial reduction in the Schumpeterian churn rate D^s. Because the presence of creation rents must be associated with a positive average gain from reallocation, $(c^h - c^{ds}) - \delta\phi\kappa$, the net welfare effect in equation (9) is negative. A pure sclerosis effect is exhibited in the β-economy. The Schumpeterian churn rate there is 0.04, which is about one-third of the rate that characterizes the efficient economy, while average labor productivity Y^s/N falls by 8 percent (table 2). The cost of lower Schumpeterian churn is 7.9 percent of GDP; it is partly offset by a selection benefit of 5.8 percent, due to the fact that increased creation rents raise the benefit of a given churn rate; the net productivity cost is 2.1 percent (table 3).

Adding financial constraints to the β-economy worsens the quality of the churn. The $\alpha\beta$-economy has a higher active churn rate $D^s + D^f$, but slightly lower average productivity Y^s/N (table 2). It gives rise to an incremental 1.0 percent net productivity cost (table 3). The fact that a higher reinvestment cost is expended to maintain lower average productivity is due to a *scrambling* phenomenon on the creation and destruction margins, that reduces the effectiveness of the churn. In the absence of financial constraints, creation and destruction decisions are based on a strict productivity-ranking of production units. When internal funds become a factor in those decisions, some units are financed that have lower productivity than others that are not. Given the creation rate H, this tends to lower the productivity of the average unit created (lower c^h). It also tends to increase the productivity of the average unit destroyed, by shifting the composition of destruction from Schumpeterian D^s to spurious D^f, with a resulting spurious-destruction cost of 2.2 percent in table 3.

4   The Cost of Recessions

The cost of recessions is a major theme in macroeconomics, for which an integrated churn perspective seems essential.[36] From an individual or representative-agent perspective, one may conclude that if a production unit is destroyed spuriously during a recession, it will need to be recreated in the ensuing recovery and will result in a wasteful reinvestment cost. As discussed in the introduction, however, extrapolating from the case of an individual production unit to the aggregate can be quite misleading. An adequate assessment of the cost of recessions requires a systematic accounting framework that considers the various margins that may respond in a churning economy. In this section we provide a framework of this type.

4.1   Business Cycle Parameters

We introduce business cycles into our economy in the form of a stochastic process for the aggregate component of firm output, $\widetilde{y}_t$. We assume that $\widetilde{y}_t$ follows an Ornstein-Uhlenbeck process:[37]

$$d\widetilde{y}_t = -\gamma(\widetilde{y}_t - \bar{y})dt + \sigma dW_t,$$

where W_t is a standard Brownian motion. The mean $\bar{y}$ of the process is equal to the steady-state value chosen in sub-section 3.2.[38] Parameters γ and σ are set equal to 0.59 and 0.18, so as to result in unemployment dynamics similar in volatility and persistence to the dynamics documented in section 5. This process implies an annual auto-regressive coefficient of about 0.4.

In calibrating the economy's steady state, we assumed that the aggregate wealth A_t of inactive entrepreneurs is exogenously given. Because the dynamics of A_t play a potentially central role over the business cycle, we now

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[36]See Hall (1995) for an attempt to measure the cost associated with maladjustment in face of recessionary episodes, that goes beyond the direct cost of temporarily unemployed resources. He multiplies estimates by Ruhm (1991) and others of workers' private loss following serious separations by the increase in the flow of these separations during recessions, and concludes that the aggregate cost for workers in the 1974-75 recession amounted to about 2 percent per year of aggregate compensation. This type of cost is not included in Lucas' (1987) classic assessment of the minor potential gains from stabilization policy.

[37]In order to simplify the exposition in section 2, we wrote the equations as if all aggregate variables had differentiable sample paths, which is clearly not the case given the process followed by aggregate shocks. Note, however, that this issue plays no role in our simulations, where time is discretized.

[38]Strictly speaking, some realizations of an Ornstein-Uhlenbeck process will violate two assumptions we made in sub-section 2.3 — namely that we restrict ourselves to parameters such that the following properties always hold: *(i)* $\pi_t^+ > 0$ and $\pi_t^- < 0$; and *(ii)* $\bar{b}_t^{f-} = 0$. We therefore need to assume that the process for $\widetilde{y}_t$ is adequately regulated so as to satisfy those two assumptions; and check that they are always satisfied in our simulations.

work with two possibilities: *(i)* A_t is constant over time; or *(ii)* the dynamics of A_t are governed by equation (7), which reflects the effect of aggregate income on liquidity. We refer to the former case as the $\alpha\beta$-economy, and to the latter as the $\alpha\beta\psi$-economy. We chose parameter values for equation (7) that can provide a potential explanation for the empirical case of "chill" we find in section 5: ψ is a linear function $\psi(y, A) = -0.009 + 0.558y - 1.94A$, which, in steady state, yields the value of A calibrated in sub-section 3.2.

4.2   Insulation, Selection and Financial Constraints over the Cycle

Figures 4.1-4.3 depict the impulse-response functions for a recessionary shock in three economies: the β-economy, the $\alpha\beta$-economy, and the $\alpha\beta\psi$-economy. For comparability, we chose the size of the shock to be such that it yields the same cumulative unemployment in the $\alpha\beta\psi$-economy as a 2-standard-deviation shock in the VAR estimated in section 5.[39] This roughly corresponds to the cumulative unemployment generated during the 1974-77 recession-recovery episode. Panels (a) and (b) depict the response of unemployment and job flows. Panel (c) depicts the cumulative response of creation and destruction, $\int_0^t H_s ds$ and $\int_0^t D_s\, ds$. Finally, panel (d) depicts the privately efficient and privately inefficient components of destruction.

Because of its importance for the ensuing discussion of the cost of recessions, our analysis emphasizes the recession's effect on the cumulative churn. We refer to a positive cumulative response as a case of turbulence following recessions, and to a negative response as a case of chill. Our view is that the economic context and circumstances will determine whether a given recession will be followed by turbulence or chill, as well as the social-welfare implications of those two scenarios. Nevertheless, because our empirical results in section 5 — based on US manufacturing data since the early seventies — are supportive of chill, we emphasize mechanisms that may underlie this type of effect. The more traditional mechanisms that underlie the opposite effect are better understood, as they have formed a basis for understanding the "liquidationist" view of recessions (e.g., De Long 1990), the interpretation of recessions as resulting from sectoral shifts (e.g., Lilien 1982), or opportunity-cost theories of recessions (e.g., Davis 1987). The chill view we emphasize is requires a different perspective.

The β-economy.   For the economy to exhibit any cyclical response, it must suffer from a labor-market problem ($\beta > 0$) that causes a form of wage rigidity. Otherwise, and off-corners, the shadow wage $\widetilde{w}$ will absorb all fluctuations in $\widetilde{y}$ with no resulting quantity response. The β-economy in figure 4.1 exhibits a positive unemployment response to the recessionary shock, that returns to steady state over time. In terms of gross flows,

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[39]See the measure of cumulative unemployment for the two-factor approach in table 6.
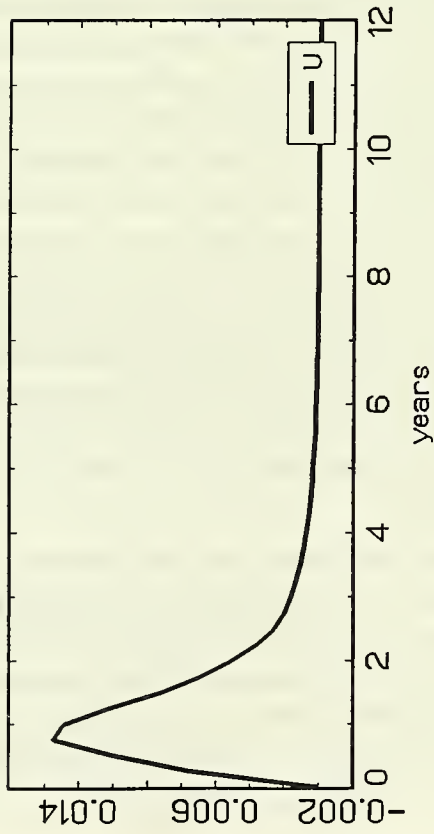
Figure 4.1a [β-economy]
Unemployment
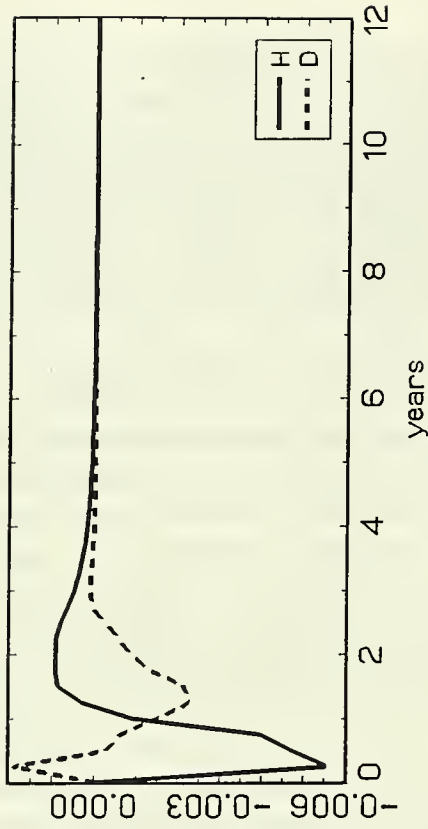
Figure 4.1b [β-economy]
Job Creation and Destruction

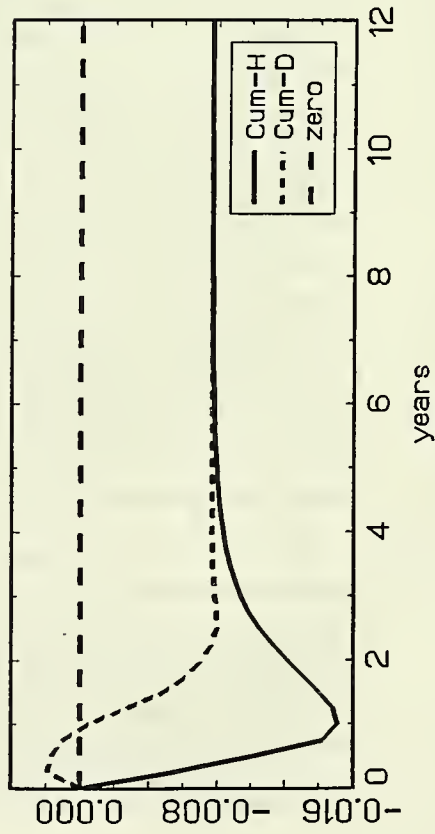Figure 4.1c [β-economy]
Cumulative Job Creation and Destruction

Figure 4.1d [β-economy]
Schumpeterian and Spurious Destruction

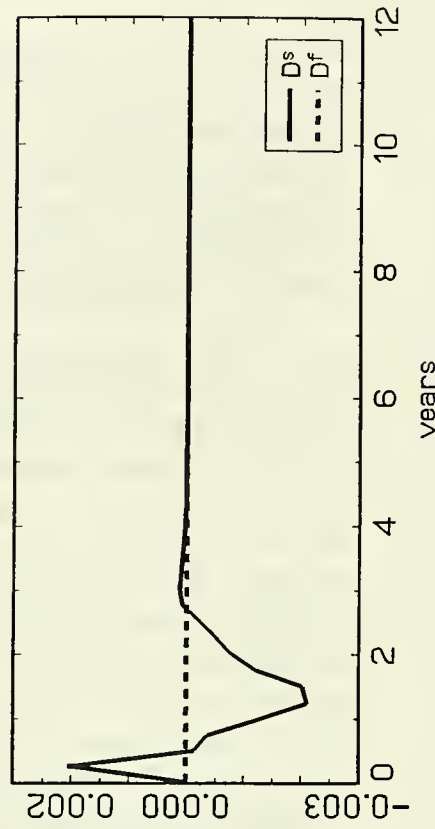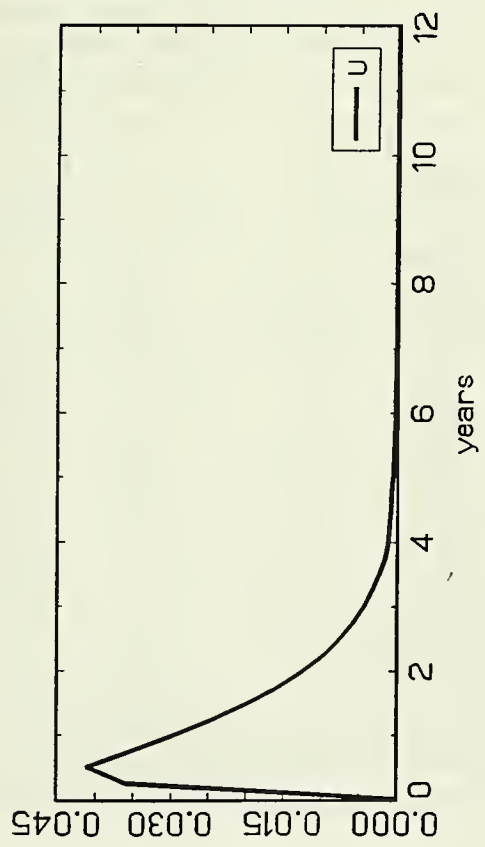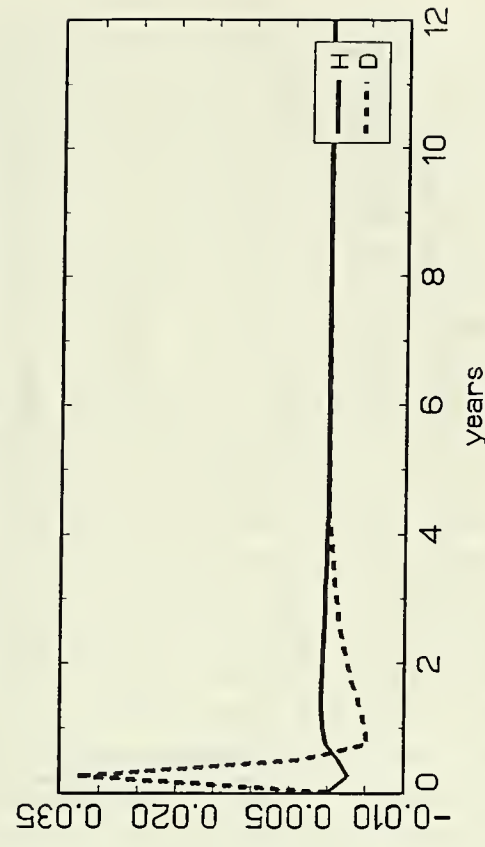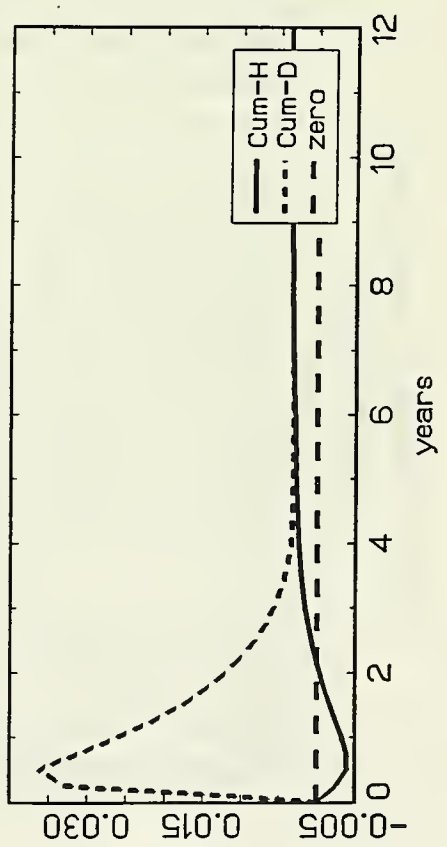Figure 4.2b [$\alpha\beta$-economy]
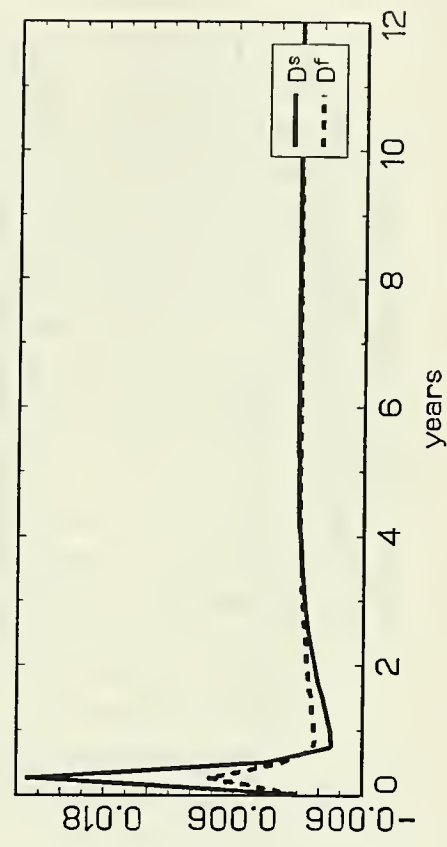Job Creation and Destruction

Figure 4.2a [$\alpha\beta$-economy]
Unemployment

Figure 4.2d [$\alpha\beta$-economy]
Schumpeterian and Spurious Destruction

Figure 4.2c [$\alpha\beta$-economy]
Cumulative Job Creation and Destruction

Figure 4.3b [$\alpha\beta\psi$-economy]
Job Creation and Destruction

Figure 4.3a [$\alpha\beta\psi$-economy]
Unemployment

Figure 4.3d [$\alpha\beta\psi$-economy]
Schumpeterian and Spurious Destruction

Figure 4.3c[$\alpha\beta\psi$-economy]
Cumulative Job Creation and Destruction
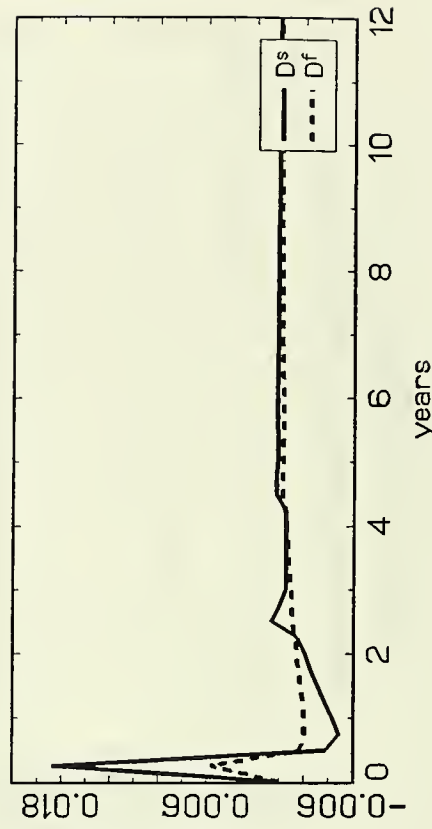
the recession materializes through both an increase in destruction and a decrease in creation. As we argue in Caballero and Hammour (1994, 1996), a response of creation tends to "insulate" the destruction margin from aggregate shocks. The economy will respond through the creation margin and fully insulate destruction, unless it faces constraints that make costly an exclusive response in creation. In the β-economy, those constraints arise from the heterogeneity of project productivities. In the single-productivity case, one can show that, off corners, the economy will respond exclusively on the creation margin. Heterogeneity in the pool of potential entrants makes the average productivity of the entrant pool rise when the rate of creation falls, which increases the cost of further decreases in creation and shifts some of the response to destruction.

The recession's effect on cumulative flows depends not only on the response of gross flows at impact, but on the manner in which the economy recovers. As can be seen in panel (c), the economy initially experiences turbulence in the form of increased destruction at impact, but ultimately ends with a decrease in cumulative destruction. The reason for this is that the recovery takes place essentially through lower-than-normal destruction, while creation simply converges back to its normal level without much overshooting. In addition to the fact that cumulative destruction is lower because employment is lower along the path, a quantitatively more important mechanism that underlies the chill is due to the selectivity of creation across project productivities. Those units that are not created during the recession are precisely units that have relatively low productivity, and therefore a high churn rate. Their absence reduces destruction in the ensuing recovery.

The $\alpha\beta$-economy. If we add financial constraints to get the $\alpha\beta$-economy, creation loses much of its cyclical responsiveness. Financial constraints induce financial rents on the creation margin that can absorb profitability shocks, which further limits the insulation mechanism. This does not mean that financial constraints have a dampening effect on *net* employment changes, quite the contrary. The increase in unemployment in figure 4.2 now peaks at nearly 4 percent, and greatly exceeds the 1.5 percent in figure 4.1. This happens as the economy's cyclical response shifts toward the destruction margin, which is more sensitive to current conditions. The greater volatility of destruction in this economy is, thus, causally related to the amplitude of economic fluctuations.

The cumulative effect of the recession on gross flows is also affected by financial constraints. With the economy responding essentially through a single margin, increases in destruction during the recession are offset by decreases during the recovery, leading to a near-zero cumulative response. The selection effect emphasized above disappears, and the economy, in fact, exhibits a small cumulative turbulence effect.

The $\alpha\beta\psi$-economy. The literature does not usually address the dampening effect on creation of financial rents. It emphasizes other mechanisms that tend to have an amplifying effect, such as the dynamics of funds available for creation (e.g., Bernanke and Gertler, 1989) or cyclical fluctuations in the value of collateral (Kiyotaki and Moore 1997). Once we add such a mechanism to get the $\alpha\beta\psi$-economy, creation becomes responsive again (compare panel (b) in figures 4.2 and 4.3). Moreover, by amplifying creation, fund dynamics dampen the response of net employment. Although creation now recovers some of the volatility it has in the β-economy, it is now partly driven by a cyclical financial constraint rather than a profitability constraint.

The chill re-emerges and is more significant than in the β-economy. However, with the scrambling induced by financial constraints, the selectivity of creation plays a less important role. The nature of fund dynamics is such that it leads to a natural shift in the margin which responds during the recession and recovery phases. While the decumulation of funds can accentuate the fall in creation during the recession, it will constrain the recovery from taking place along that margin until enough funds are accumulated again. The result is a shift from the creation to the destruction margin in the recovery phase, which results in a significantly negative cumulative reallocation.

The economy exhibits interesting non-linearities. Although destruction is nearly four times more responsive to a large negative shock than creation, the ratio of the overall standard deviations of destruction to creation is only 1.5 — roughly the same as in the US manufacturing sector. This is essentially due to a substantial difference in the economy's response to negative versus positive shocks. Relative to creation, destruction responds much more to a negative than to a positive shock. This feature has been documented for US manufacturing gross flows (e.g., Caballero and Hammour 1994). As a result, unemployment responds more to a negative than a positive shock. This asymmetry in net employment fluctuations is reminiscent of features documented for the US economy as a whole (see, e.g., Sichel 1989), and arises out of a fully symmetric shock process.

4.3   Recession and Recovery: Net Social Costs

To account for the full social costs of a recession, we derive a welfare decomposition similar to that in subsection 3.1. Assume the economy starts in steady state, and experiences an aggregate shock to $\tilde{y}$ at time $t = 0$.[40] If this

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[40]The steady state we assume here is one where the possibility of aggregate shocks is anticipated by agents, but not realized. It works as an attractor for the economy's dynamics. This is different from the steady state with deterministic aggregate conditions analyzed in section 3, because the value functions Π^+ and Π^- are affected by the possibility of aggregate shocks.

shock affects "real" productivity, an obvious *direct* social loss — which also affects the efficient economy — results from lower productivity in all units. In order to separate the costs of inefficient churn from this direct cost, we assume that the shock to $\tilde{y}$ is due to an "aggregate distortion" — e.g., due to a distortionary tax on gross output that is redistributed lump-sum. To compare the recession path of any variable X_t with its steady-state value $\overline{X}$ in the absence of a shock, we redefine $\widehat{X}_t \equiv X_t - \overline{X}$ and define the resulting present-value operator

$$\mathcal{L}_X \equiv \int_0^\infty \widehat{X}_t e^{-\rho t}\, dt.$$

We also define, for any two variables X_t and Y_t, the interaction operator

$$\mathcal{X}_{X,Y} \equiv \int_0^\infty \widehat{X}_t \widehat{Y}_t e^{-\rho t}\, dt.$$

Following an approach similar to our steady-state analysis, we decompose the present-value social welfare effect of a recession into a component related to the direct cost of unemployment $\mathcal{L}_U$, adjusted for the passive effect of δ-destruction, and a term that captures the cumulative increase and change in composition of the economy's active churn $\mathcal{L}_{D^s + D^f}$, which is equal to

$$\mathcal{L}_{D^s + D^f} = \mathcal{L}_H + (\rho + \delta)\mathcal{L}_U \tag{10}$$

as long as U converges back to steady state.[41]

The recession's effect on the present value of welfare can then be written as

$$
\begin{aligned}
\mathcal{L}_W = \ & -(\rho + \delta)\left(\overline{V}^h - \phi\kappa\right)\mathcal{L}_U \\
& + \left(\overline{V}^h - \overline{V}^{ds} - \phi\kappa\right)\mathcal{L}_{D^s + D^f} \\
& - \left(\overline{V}^{df} - \overline{V}^{ds}\right)\mathcal{L}_{D^f} \\
& + \left(\overline{H}\mathcal{L}_{V^h} - \overline{D}^s \mathcal{L}_{V^{ds}} - \overline{D}^f \mathcal{L}_{V^{df}}\right) \\
& + \mathcal{X}
\end{aligned}
\tag{11}
$$

where

$$
\begin{aligned}
V_t^h &\equiv \frac{\overline{y}^s + \nu_t^h}{\rho + \delta} + \frac{\epsilon}{\rho + \delta + 2\lambda}; \\
V_t^{ds} &\equiv \frac{\overline{y}^s + \nu_t^{ds}}{\rho + \delta} - \frac{\epsilon}{\rho + \delta + 2\lambda}; \\
V_t^{df} &\equiv \frac{\overline{y}^s + \nu_t^{df}}{\rho + \delta} - \frac{\epsilon}{\rho + \delta + 2\lambda};
\end{aligned}
$$

---

[41]If U converges back to steady state, integration by parts yields $\mathcal{L}_{\dot{U}} = \rho\mathcal{L}_U$. Expression (10) now follows from the flow equation relating the rate of change in unemployment and job flows.

and

$$\mathcal{X} \equiv \mathcal{X}_{H,V^h} - \mathcal{X}_{D^s,V^{ds}} - \mathcal{X}_{D^f,V^{df}}.$$

V_t^h measures the average social value of creating a production unit; V_t^{ds} and V_t^{df} measure the average social loss from privately efficient and privately inefficient destruction. Equation (11) breaks down the welfare effect of a recession into five components. The component on the first line denotes the unemployment effect, adjusted for the passive response of δ-destruction; the second line denotes the productivity effect due to changes in the pace of the active churn net of the reinvestment cost, based on the social value of units on the Schumpeterian margin; the third line measures the productivity effect due to the private inefficiency of spurious destruction; the fourth line denotes an additional productivity effect that arises from changes in the selectivity of creation and destruction; and the last line contains an interaction term.[42]

The unemployment term is equal to the cumulative employment effect of the recession, $-\mathcal{L}_U$, multiplied by the flow social value $(\rho + \delta)(\overline{V}^h - \phi\kappa)$ of a production unit. The productivity terms represent a potential cost of maladjustment in addition to the unemployment cost. They are essentially a function of the present value $\mathcal{L}_{D^s+D^f}$ of the response of active destruction to the recessionary shock, as well as the response of the composition of gross flows over time. If destruction is privately efficient, the social value of a unit-increase in cumulative reallocation is $\overline{V}^h - \overline{V}^{ds} - \phi\kappa$. It is equal to the *private* value increase from updating a production unit, minus the reinvestment cost. Because of private rents on the creation margin, this social value is positive. This means a chill scenario, that involves a decrease in cumulative destruction ($\mathcal{L}_{D^s+D^f} < 0$), is socially costly.[43] For the privately inefficient component of destruction, one must subtract from this the private loss $\overline{V}^{df} - \overline{V}^{ds}$ of separation. The resulting net social value of increased reallocation is smaller, but still positive with our chosen parameters because we calibrated rents to be greater on the creation than on the spurious destruction margin.

Tables 4 and 5 compute the social-welfare decompositions that correspond to the impulse-response functions in figures 4.1-4.3 for the β-economy, the $\alpha\beta$-economy, and the $\alpha\beta\psi$-economy. Social costs can again be interpreted as a percentage of steady-state annual GDP in the financially constrained economy.

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[42]This welfare decomposition corresponds to equation (1) in the introduction, once we substitute (10) for $(\rho + \delta)\mathcal{L}_U$ into (11) and make the obvious notational change. For simplicity, our discussion of equation (1) ignores the rents that accrue to project productivities.

[43]As long as a recession largely materializes along the destruction margin, discounting tends to "bias" the social-cost outcome toward turbulence. This is because the present value of social welfare puts a larger weight on the initial increase in destruction than on any future decreases.

Table 4: Response to a Recessionary Shock

	β-economy	$\alpha\beta$-economy	$\alpha\beta\psi$-economy
$\mathcal{L}_U$	0.022	0.057	0.046
$\mathcal{L}_H$	-0.008	0.003	-0.024
$\mathcal{L}_{D^s}$	-0.006	0.011	-0.003
$\mathcal{L}_{D^f}$	-	-0.002	-0.015

Table 5: Welfare Effect of a Recession

	β-economy	$\alpha\beta$-economy	$\alpha\beta\psi$-economy
Unemployment	-0.017	-0.044	-0.035
Churn	-0.003	0.008	-0.015
Spurious Destruction	-	0.001	0.007
Selection	0.002	-0.002	-0.002
Interaction	-0.001	-0.001	-0.001
Productivity	-0.002	0.006	-0.011
Total	-0.019	-0.037	-0.046

The social cost of a recession in the β-economy is 1.9 percent of GDP. It is essentially due to an unemployment cost of 1.7. Productivity only adds another 0.2 percent. Although a lower cumulative churn is harmful in an economy that suffers from sclerosis, it is less so once we consider that it mostly comes out of not updating to relatively low-productivity units. This is why the selection term reduces by nearly a half the social cost of reduced churn.

The $\alpha\beta$-economy exhibits much more responsive unemployment, whose cost is increased to 4.4 percent. The small cumulative turbulence effect is somewhat amplified by discounting, since the earlier turbulent episode enters the social cost calculation with a greater weight. This turbulence effect is beneficial in an economy that suffers from sclerosis. The welfare effect associated with productivity is now a benefit, equal to 0.6 percent. This highlights the delicate nature of social cost accounting in a churning economy. The net cost of a recession is now 3.7 percent.

Although the $\alpha\beta\psi$-economy exhibits a smaller response and cost of unemployment than the $\alpha\beta$-economy — equal to 3.5 percent — the net social cost of a recession is a larger 4.6 percent. The reason for this is that the

chill adds another 1.1 percent to the cost. Compared to the β-economy, the chill is both larger and more inefficient. This is because reduced churn occurs much less selectively in the presence of financial constraints. Because of scrambling in creation, it is less true that units that are not created are those whose productivity would yield the least updating benefit. Although, on the surface, the $\alpha\beta\psi$-economy and the β-economy both exhibit a chill effect, the selection term adds to the cost of the former while it subtracts from the cost of the latter.

5 Semi-structural Evidence: A Case of Chill

The goal of this section is to provide an empirical application of our welfare decomposition, imposing substantially less structure than that embodied by our model. Using semi-structural VARs and related procedures, we find that during the 1972–1993 period, US manufacturing typically experienced a chill following recessions.[44] Multiplying this effect by the average shadow values calibrated for our model, we conclude that this effect adds significantly to the cost of recessions. We estimate a 2-standard-deviation recessionary shock — more or less what is needed to generate a response of the size of 1974-75 aggregate recession — to be associated with an unemployment cost of 3.5 percent and a productivity cost of 1.4 percent of GDP.

5.1 The Data

Figure 5.1 depicts our data. The solid line in panel (a) depicts the path of quarterly US manufacturing employment during the period 1972:1–1993:4, divided by its mean. This is our main employment series. As a reference, the dashed line in the same figure presents a rescaled version of the economy-wide unemployment series.[45] It is clear that its cyclical features are highly consistent with those of manufacturing employment. We build on this observation later on, when treat manufacturing employment as stationary — a hypothesis we test and do not reject. Panel (b) reports the path of gross job creation and destruction *flows*, defined as the basic quarterly creation and destruction *rates* reported by Davis, Haltiwanger and Schuh (1994, henceforth "DHS") multiplied by the (lagged) aggregate employment series reported in panel (a).[46] Over 95 percent of the variation in our job

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[44]Since the empirical models in this section are linear, there is full symmetry between recessions and expansions.

[45]Source: FRED. The rescaled unemployment series is a linear transformation $a - bU$, where U is the US civilian unemployment rate.

[46]More precisely, DHS calculate their creation and destruction rate series as the ratio of job flows to average employment for plants in their sample. For consistency, we first transform the denominator of the DHS series from average to lagged employment. We

Figure 5.1a
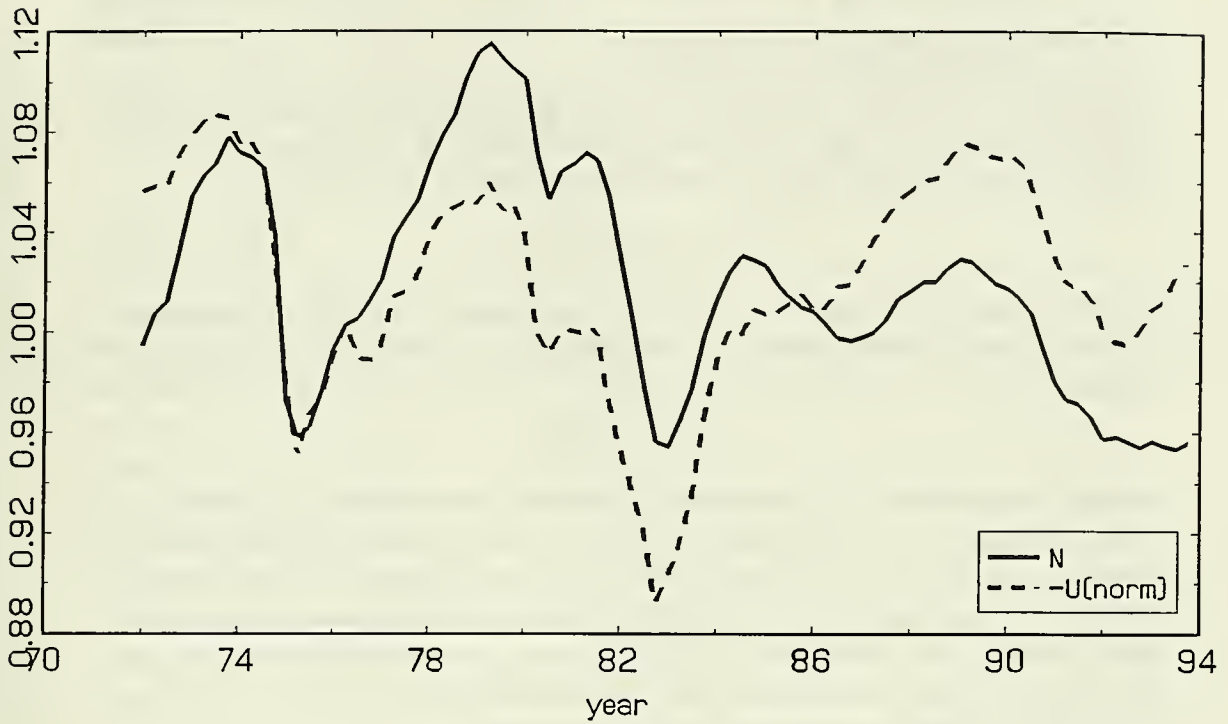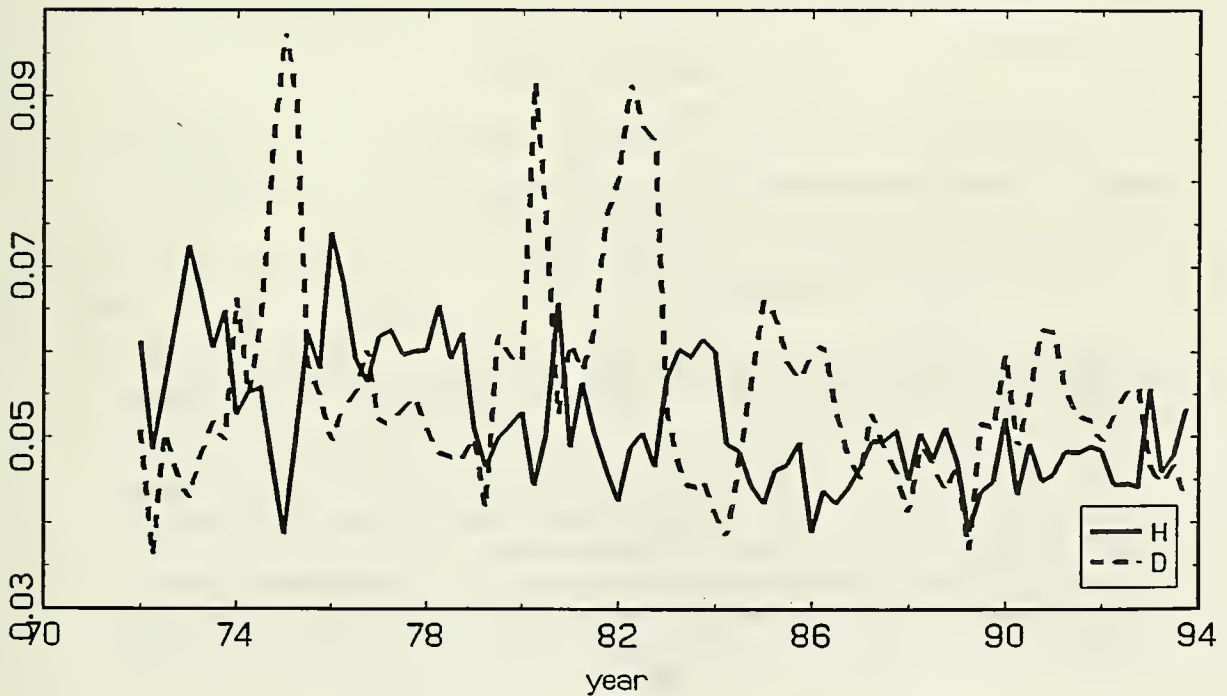## Manufacturing Employment and (−) Civilian Unemployment

Figure 5.1b
Job Creation and Destruction Flows

creation and destruction flows comes from the variation in the DHS rates. All data are seasonally adjusted using the Census X11 procedure.[47]

5.2 Impulse-Response Functions

We follow two related approaches, aimed at tracing the average impact of an "aggregate" business cycle shock on job flows and unemployment. Both build on the "identity" relating employment changes and job flows:

$$\Delta N_t = H_t - D_t. \tag{12}$$

If shocks have only transitory effects on employment, then the net response of job flows to these shocks must "integrate to zero." In other words, the series

$$\int_0^t (H_s - D_s)\,ds$$

should be stationary.[48] We test this constraint successfully, and use it to gain statistical power. Our main concern is with the decomposition of this integral. Zero can be achieved through any combination of equally sized individual integrals, $\int_0^t H_s ds$ and $\int_0^t D_s\,ds$, which may reflect a case of turbulence or chill. Our main result is that, regardless of which procedure we use, the individual integrals (discounted or not) are clearly negative — resulting in a chill — after a recessionary aggregate shock.

Single-Factor Approach. Assuming that aggregate shocks are the only driving factor behind employment fluctuations, we can identify the response of job flows to aggregate shocks by running the following simple regressions:

$$H_t = \theta^h(L)(-N_t) + \epsilon_t^h; \tag{13}$$

$$D_t = \theta^d(L)(-N_t) + \epsilon_t^d; \tag{14}$$

where L is the lag-operator and $\theta^x(L)$ represents $(\theta_0^x + \theta_1^x L + ...)$. In particular, we report results for the following specification:[49]

$$\theta^x(L) = \frac{\eta_0^x + \eta_1^x L + \eta_2^x L^2 + \eta_3^x L^3}{1 - \rho^x L}, \quad x \in \{h, d\}.$$

then multiply by lagged manufacturing employment, measured in the middle month of the quarter, to obtain our flow series.

[47]Instead of using aggregate manufacturing employment, we could have used employment in the DHS sample. The latter series has a time-trend that is not present in the former, but the two are otherwise broadly consistent. We ran our regressions using the DHS employment series and obtained very similar results.

[48]Hall (1997) refers to series whose integrals are stationary as "concentrated" series.

[49]Our qualitative, and to a large extent quantitative, results are robust to different lag structures.

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If equation (12) holds exactly, then $\epsilon_t^h = \epsilon_t^d$ and only one of the two flow-equations needs to be estimated to recover both sets of parameters.[50] However, since our job flow series are the product of DHS rates times lagged manufacturing employment rather than DHS employment, there is an additional residual in (12) and therefore a reason to estimate both flow equations.

Panels (a) and (b) of figure 5.2 portray the estimated impulse-response of (minus) employment and job flows, respectively, to a 2-standard-deviation recessionary shock. The path of (minus) employment offers no surprises. The paths of job flows, on the other hand, are more interesting. As is well documented by DHS, in the short run job destruction rises sharply and job creation declines to a lesser extent, leading to an observation of turbulence. Less known is what comes next: turbulence disappears over time and is replaced by a chill. Along the recovery path, job destruction declines and remains below average for a significant amount of time, while job creation does not exceed its average for long enough to offset its initial decline. Panel (c) summarizes these findings by reporting the cumulative responses of job creation and destruction.

More formally, the stationarity of employment implies that

$$\theta^h(1) - \theta^d(1) = 0. \tag{15}$$

We test this hypothesis and do not reject it at any reasonable significance level. Estimating jointly equations (13) and (14) without imposing stationarity constraint (15) yields a likelihood of 675.5, while imposing (15) only lowers the likelihood to 674.8.

The chill corresponds to the result that the constraint

$$\theta^h(1) = \theta^d(1) = 0$$

is clearly rejected — the likelihood drops to 671.4 — in favor of an alternative that sets

$$\theta^h(1) = \theta^d(1) < 0.$$

On a series-by-series basis, it is destruction that is mostly responsible for this rejection.[51]

Two-Factor Approach. Aggregate business cycle shocks are probably not the only factor behind employment fluctuations. In this second approach,

_____

[50]This is true under the maintained assumption that only aggregate shocks affect employment.

[51]Estimating equation (13) separately with and without the constraint that $\theta^h(1) = 0$ yields likelihoods of 346.8 and 347.3, respectively. Doing the same for (14) with and without the constraint $\theta^d(1) = 0$ yields likelihoods of 323.5 and 327.0, respectively.

Using a univariate time series procedure, Hall (1997) cannot reject that the integral of job destruction is a stationay series. Our regressions (and VARs below) have additional statistical power, which is probably responsible for the rejections we find.

Figure 5.2a
Impulse response (single factor): (minus) Employment
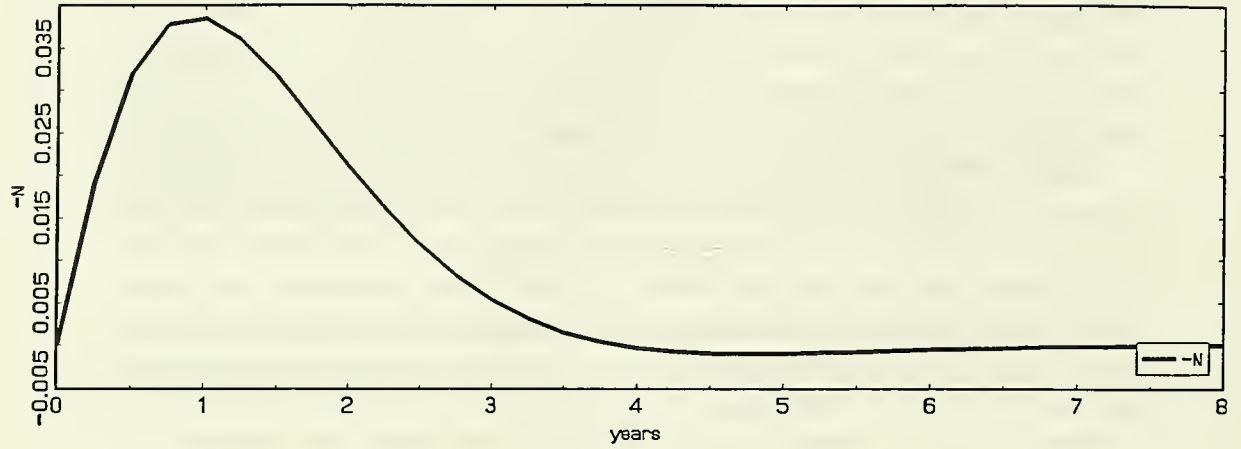

Figure 5.2b
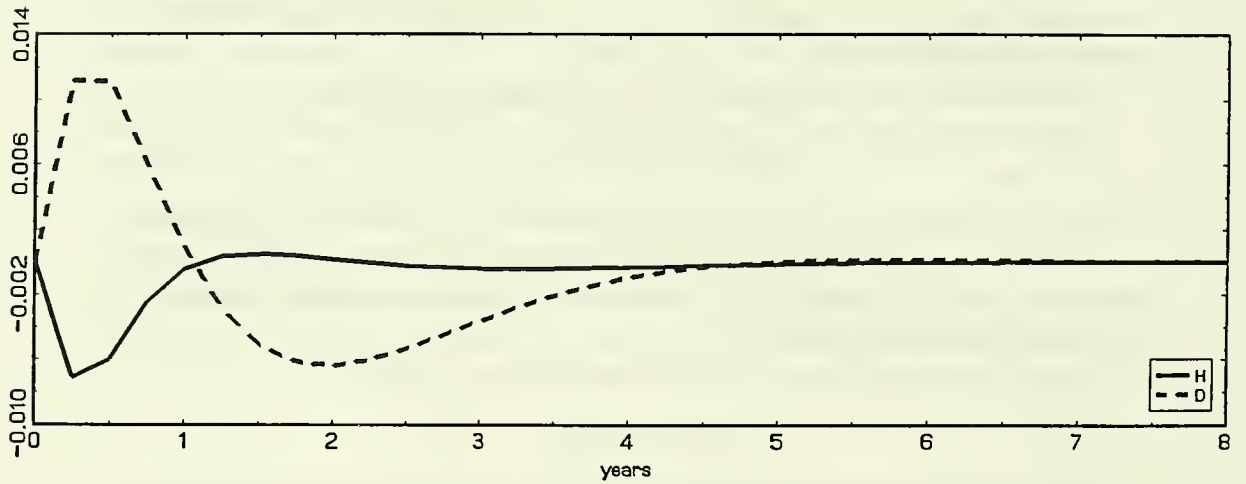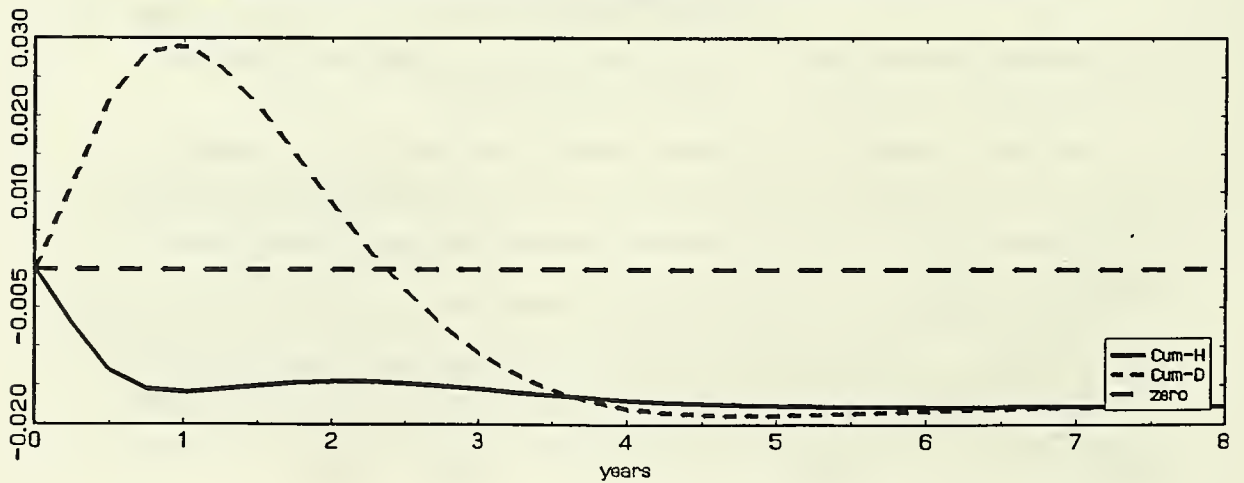Impulse Response (single factor): Job Creation and Destruction

Figure 5.2c
Impulse Response (single factor): Cumulative Job Creation and Destruction

we assume the presence of two shocks with the potential to affect job flows and employment. We use a semi-structural VAR approach to identify those shocks.

Given the test of (15) above, we maintain the assumption that manufacturing employment is stationary. By equation (12), this implies that the integral of $H - D$ must be stationary.[52] Equivalently, it implies that the integrals of H and D must be cointegrated with cointegrating vector $(1, -1)$. Using this low-frequency restriction efficiently suggests running a VAR with one of the integrals first-differenced (e.g., job destruction) and the cointegrating vector, which is equal to employment.[53]

We write our semi-structural VAR as

$$\begin{bmatrix} N \\ D \end{bmatrix} = A(L) \begin{bmatrix} \epsilon^a \\ \epsilon^r \end{bmatrix},$$

where $A(L) = A_0 + A_1 L + A_2 L + ...$ and (ϵ^a, ϵ^r) represent i.i.d. innovations that correspond to aggregate and reallocation shocks, respectively. Besides normalizations, achieving identification requires two additional restrictions. For this purpose, we assume that the two innovations are independent of each other, and that, at impact, a recessionary shock raises destruction and lowers creation. Based on Davis and Haltiwanger (1996), we set the relative size of the absolute response of destruction compared to creation to 1.6, which is roughly the value that maximizes the contribution of aggregate shocks to net employment fluctuations with their estimates. We experimented with values of the relative size of the absolute response of destruction to creation in the range $[1, 2]$, without a significant change in our main conclusions.

Since we are particularly concerned with medium and low frequency statistics, we used a fairly non-parsimonious representation of the reduced-form VAR and allowed for 5 lags. The first and second columns of figure 5.3 represent impulse-response functions corresponding to recessionary 2-standard-deviation aggregate and reallocation shocks, respectively, for (minus) employment, gross flows, and cumulative gross flows. The first column exhibits a case of chill following recessionary aggregate shocks, which is qualitatively similar and quantitatively larger than the chill obtained with the single-factor approach. The second column depicts responses to reallocation shocks, which, not surprisingly, generate turbulence. They also seem to lower unemployment in the medium term.[54]

---

[52]We have already mentioned that equation (12) is not exact when one uses manufacturing rather than DHS employment. For our claim to hold, this difference must also be stationary (possibly with a deterministic trend) — a hypothesis we cannot reject.

[53]The system could also be run using the two flows — which is the standard procedure in the literature (e.g., Davis and Haltiwanger 1996) — but this is inefficient when their integrals are cointegrated.

[54]Our qualitative results are robust to the number of lags used (we tried between 2

Figure 5.3a
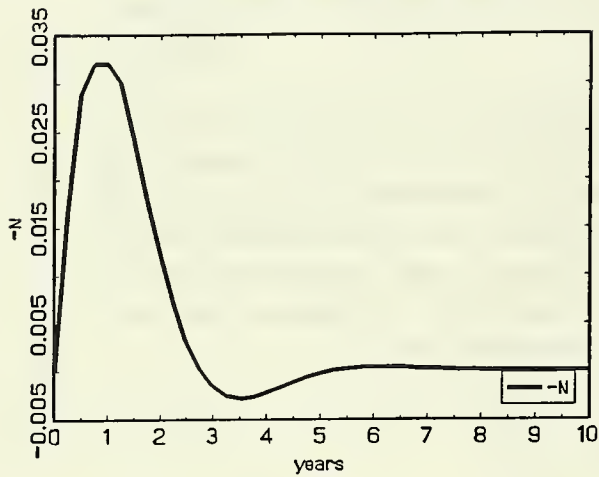Aggr. Impulse: (minus) Employment
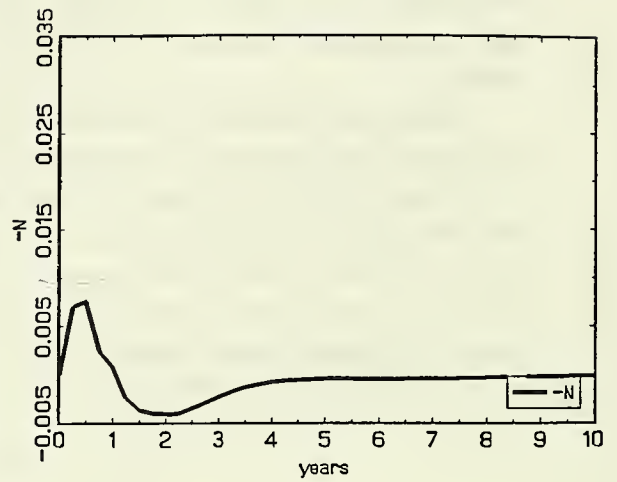
Figure 5.3b
Reall. Impulse: (minus) Employment

Figure 5.3c
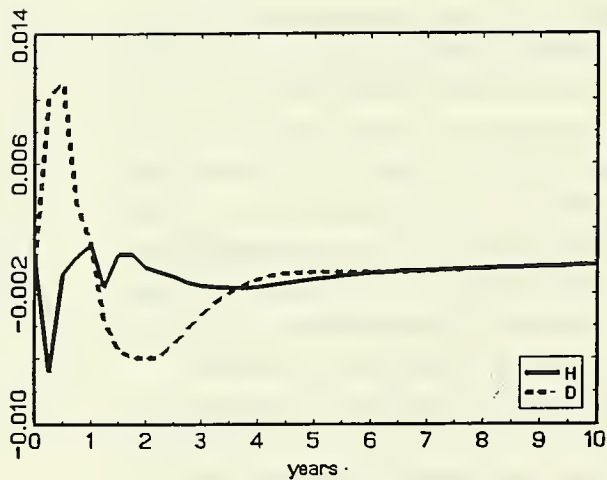Aggr. Impulse: Job Creation and Destruction

Figure 5.3d
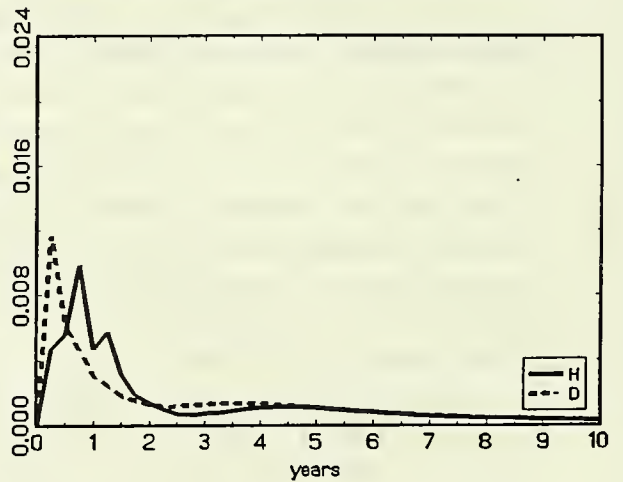Reall. Impulse: Job Creation and Destruction

Figure 5.3e
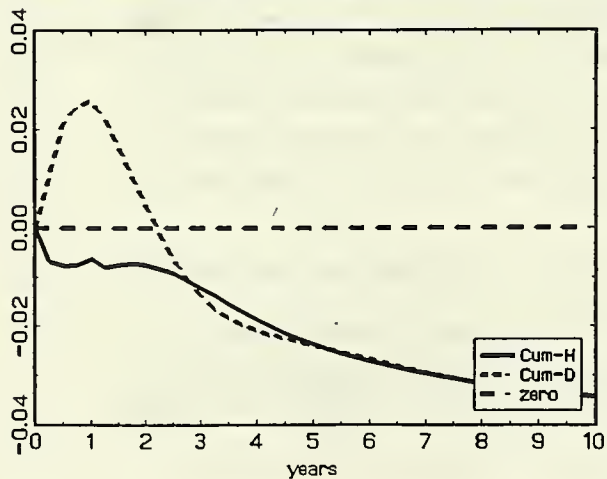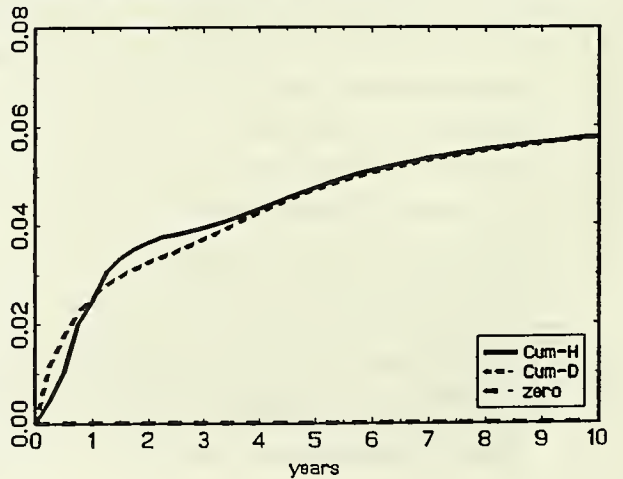Aggr. Impulse: Cum. Job Creation and Destruction

Figure 5.3f
Reall. Impulse: Cum. Job Creation and Destruction

To test the hypothesis of no chill, we generated 10,000 bootstrap replications and computed the corresponding discounted present values. Figure 5.4 shows the histograms of the present values that correspond to the quantities in table 6 (see below). It is clear from this figure that the chill finding is significant.[55]

5.3 The Cost of Recessions Revisited

Table 6 reports the cumulative discounted response of unemployment (i.e., of minus employment) and job flows associated with a recessionary aggregate shock, as implied by our two sets of estimates. As before, in each case the experiment corresponds to a 2-standard-deviation aggregate shock. With the two-factor approach, $\mathcal{L}_U$ roughly corresponds to the cumulative aggregate unemployment that was generated in the US during the 1974-77 recession-recovery episode.[56]

Table 6: Cumulative Quantity Effects of the Aggregate Shock[57]

	Single-Factor Approach	Two-Factor Approach
$\mathcal{L}_U$	0.054	0.046
$\mathcal{L}_H$	-0.014	-0.030
$\mathcal{L}_D$	-0.010	-0.027
$\mathcal{L}_{D^s+D^f}$	-0.007	-0.024

Based on the quantity responses in table 6, we can use the social values calibrated for the $\alpha\beta\psi$-economy and the compositional effects in table 5 to calculate the associated social cost. Based on the two-factor approach, the cost of the recession is 4.9 percent of GDP, which can be broken down into a 3.5 percent unemployment cost and a 1.4 percent productivity cost.

It is interesting to compare our figure to a slightly modified version of the traditional estimates based on Okun's gap, which we construct as the discounted cumulative gap between potential and actual output during a full recession-recovery episode. For comparability, we subtract back the reinvestment benefit $\phi\kappa\mathcal{L}_{D^s+D^f+D^\delta}$ from the cost calculated above, and obtain a cost

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and 6 lags), to whether the 1974-75 recession is excluded, or to estimating the VAR for $(\ln N, D/N)$ rather than (N, D).

[55] The 95 percent confidence interval ranges from -0.01 to -0.05 for $\mathcal{L}_D$.

[56] We calculated a value of $\mathcal{L}_U = 0.044$ for the period 1974:4-1977:3.

[57] The table uses the same discount and failure rates as in our model: $\rho = \delta = 0.06$. Active destruction is calculated as $\mathcal{L}_{D^s+D^f} = \mathcal{L}_D + \delta\mathcal{L}_U$.
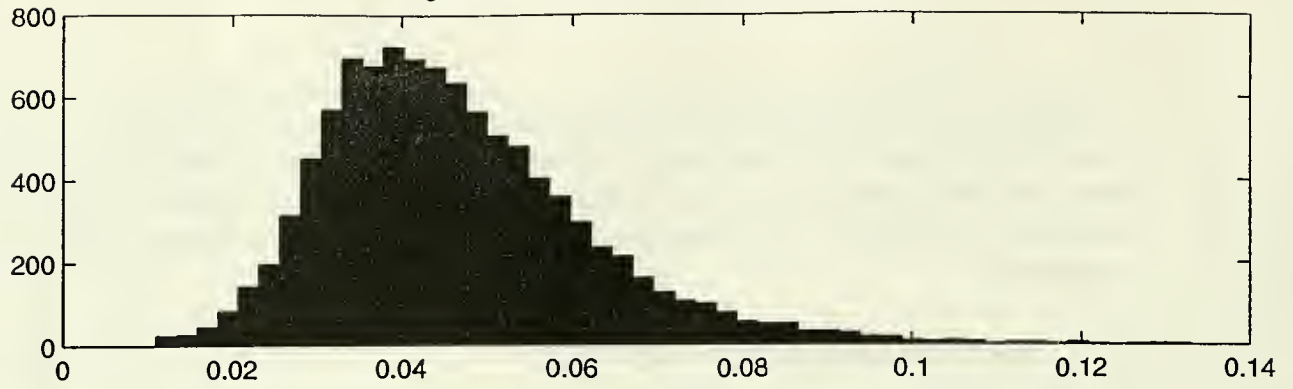
Figure 5.4a   10000 L(U) bootstrap samples

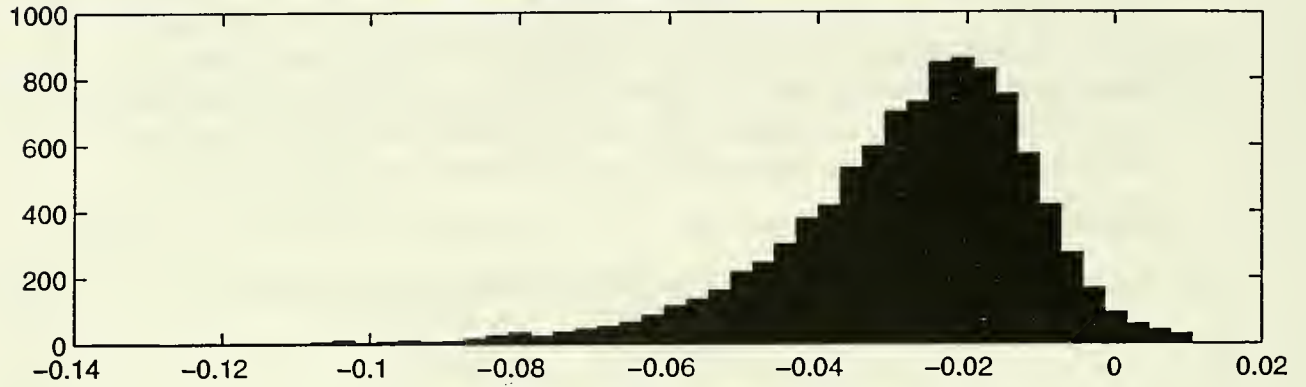Figure 5.4b   10000 L(H) bootstrap samples
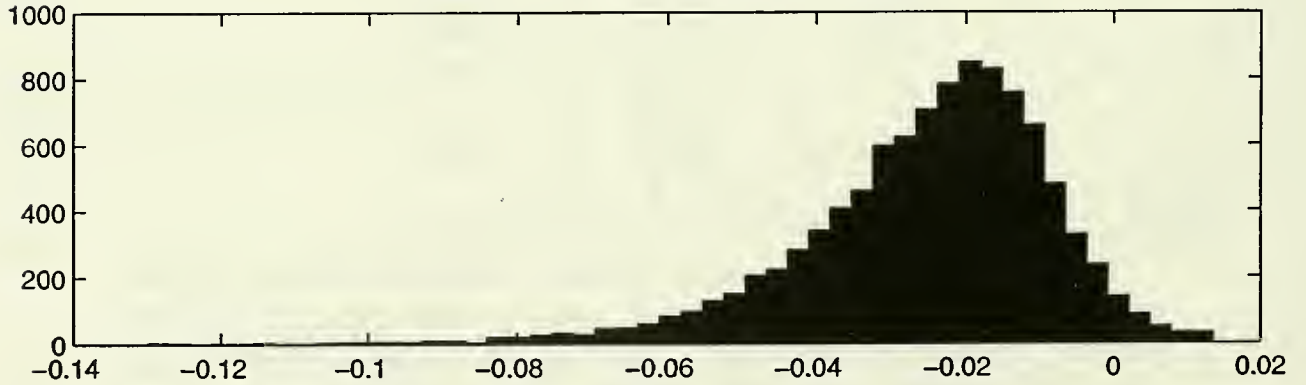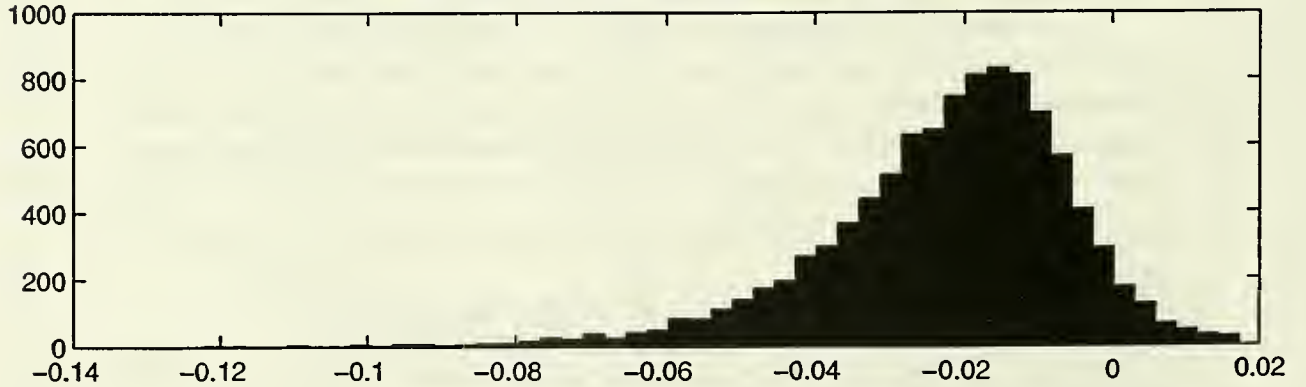
Figure 5.4c   10000 L(D) bootstrap samples

Figure 5.4d   10000 L(Df+Ds) bootstrap samples

of 6.7 percent of GDP. This can be compared with the Okun-gap estimate of 5.6 percent of average potential GDP for the 1974-77 recession-recovery episode, based on the output-gap estimates in Gordon (1997).[58]

6 Conclusion

Even in the relatively efficient context of the US economy, we calculate that in an average year unemployed resources cost about 4.6 percent of annual GDP; and that, following a significant recession, the cumulative social cost of unemployment due to maladjustment is about 3.5 percent of annual GDP. Productivity considerations may add to or subtract from the unemployment-cost of a recession, depending on whether it results in cumulative chill or turbulence. Exploring US data, we find that the increase in "reallocation" (the sum of job creation and destruction) at the impact of a recessionary shock is more than offset by a cumulative decline along the recovery path. If we interpret this chill as resulting from financial constraints, we calculate that it makes recessions about 40 percent costlier than what one would conclude based on the unemployment cost alone.

Pretending that these numbers are anything more than speculative estimates based on highly stylized concepts would be absurd. Nonetheless these conclusions, as well as the mechanisms and framework underlying them, should provide a useful reference to organize a discussion on the actual costs of the churn and recessions.

It is useful to retrace our steps, and highlight some of the key assumptions, modeling choices and weaknesses of our analysis. Underlying this research is a view of the churn as a central concept in assessing the implications of factor market frictions for aggregate quantities and social welfare. Our flows-based social accounting framework is of independent interest from our model. Indeed, we built our estimates of welfare costs based largely on existing evidence on US job flows, rent sharing, and the private costs of separations. This body of evidence naturally comes with its pitfalls and weaknesses.

The model has essentially two roles in our analysis: *(i)* through its success in matching observed quantities, it allows us to offer a consistent view of the mechanisms that could be at work in generating these quantities and of their potential welfare implications; and *(ii)* it allows us to characterize equilibria in "unobserved" economies, including the reference efficient economy.

Underlying our approach is a unified treatment of contracting difficulties in factor markets. Capital specificity leads to opportunistic behavior in

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[58]For the 1980-87 episode, the Okun-gap estimate is 14.8 percent of average potential GDP; for the 1990-93 episode, it is 2.2 percent.

the owners-workers relationship as well as in the manager-financier relationship. In equilibrium, the former friction generates underinvestment, sclerosis and involuntary unemployment. Besides amplifying these illnesses, financial market frictions add scrambling, by which we mean a partial breakdown in the productivity-ranking of creation and destruction decisions.

Over the business cycle, labor market frictions bring a form of real wage rigidity. Financial market frictions leverage on this rigidity and relocate the burden of adjustment from the creation to the destruction margin. In fact, given internal funds, financial rents tend to insulate creation from aggregate shocks, further adding to real wage rigidity by preserving new job opportunities, and therefore leaving the destruction margin exposed to the full force of the recessionary shock. The cyclical dynamics of funds available for creation — or similar effect due to dynamics in the value of general collateral, e.g. — partially reduce the insulation of creation decisions.[59] Moreover, if creation is severely constrained along the recovery path, aggregate employment may recover through a persistent decline in destruction after its initial surge, exacerbating the ingrained sclerosis problem brought about by factor market frictions.

In sum, perhaps more important than the specific numbers we generated, this paper has provided an integral picture of the way a churning economy functions, and of the disruptions caused by transactional difficulties in labor and financial markets. We highlighted the rich range of recession-recovery possibilities offered by a churning economy, and the welfare costs associated with these alternative paths and with the frictions behind them.

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[59]Our model is rather primitive in its treatment of this channel. Adding an endogenous price of general capital or an explicit dynamic model of the distribution of potential entrants are natural and important extensions.

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